A COMPARATIVE STUDY OF TEACHING MATHEMATICS BY THE METHOD OF PROGRAMMED INSTRUCTION AND CONVENTIONAL CLASSROOM METHOD

ABSTRACT

THESIS SUBMITTED TO THE
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ABSTRACT

Topic: A comparative study of teaching mathematics by the method of programmed instruction and conventional classroom method.

The study has been mainly concerned with comparison of two approaches to teaching, viz., programmed instruction and conventional classroom methods. Since learning takes place in human beings, it is likely to be affected by learners characteristics. Because of this reason, the present investigation analysed learning outcomes in the context of certain learner characteristics.

A review of relevant researches has revealed that students learn better with programmed instruction than with conventional method. Doubts have, however, been raised regarding the term "conventional method" which in most of the studies, has been loosely defined. According to Cheris (1964), that as it is not usually possible to scrutinize classroom teaching, so it cannot be established that, in any given situation, programmed instruction and conventional method have covered the same material to the same depth. Doubts have also been raised regarding the effectiveness of

programmed instruction for all personality types of students (Fry, 1963). Studies undertaken during 1960's suggested that achievement through programmed instruction is not only a function of the method but also a function of learner's characteristics like intelligence, creativity, anxiety, need achievement, study habits, introversion-extraversion etc. There have also been researches (as for example by Glaser and Reynold- 1962, Feldhunsen and Eigen - 1963, Nagar - 1971, Govinda - 1976) which have claimed that programmed instruction minimises the gap between achievement levels of groups high and low in characteristics which were understood to be determinants of learning.

Thus, it appeared that the relationship between learners personality and his achievement through different methods of instruction may be more complex than has been generally recognised. In this context, it was thought worthwhile to conduct this study with the following objectives:

(a) To compare the outcomes of learning mathematics through the method of programmed instruction and the conventional classroom method.

(b) To find out whether intelligence of students is differentially related to their achievement and retention when they learn mathematics through the aforesaid two method.

(c) To ascertain whether achievement and retention through programmed instruction and conventional method are differentially related to introversion-extraversion.

(d) To determine whether the achivement and retention scores of students learning through programmed instruction or conventional method are influenced by variable rigidity-flexibility.

(e) To find out whether study habits have any differential relationship with achievement and retention of students when taught by programmed instruction or conventional method.

(f) To determine whether previous attainment of students has any differential relationship with their achievement and retention scores when taught by either of the aforesaid two methods.

The topic selected for teaching students by means of the two methods was "Set Theory" from modern mathematics. The author developed programmed instructional material following the usual steps. The conventional method was not left undefined. With the help of teachers who participated in the present experiment, a plan of presenting the subject matter to the students was chalked out. The Herbartian steps with Heuristic approach were followed in teaching the students.

The investigation was conducted on a sample of 378 students taken from 12 sections of IX class from eight different higher secondary schools in Jaipur City. The sample was divided into two equal groups of 189 students each, out of which one, the experimental group, was taught through programmed instruction and the other, the control group, by the conventional method of teaching. It was ascertained that the two groups did not differ much in factors like age, socio-economic status and locality of habitat.

The relevant data were obtained by administering Jalota's General Mental Ability Test (1964), Hindi version of Maudsley Personality Inventory (Jalota and Kapoor, 1965), Gough-Sanford Rigidity Scale (Ali, 1975), Rastogi's Study Habit Inventory (1966), a Previous-Achievement-Test, a Post-Achievement-Test and a delayed test of achievement (Retention Test). For analysing the data, analysis of variance with 2 x 2 x 2 factorial design was used. The achievement and retention scores were treated as dependent variables whereas the two methods of instruction, and learner characteristics, namely, intelligence, introversion-extraversion, rigidity-flexibility, study habits and previous attainment, were treated as independent variables.

Reviewing the analysis of variance tables in which analysis of achievement scores has been done, it is noted that in all cases the main effect of method of teaching is significan The mean of achievement scores for programmed instruction group is in each case higher than that for the conventional group. Thus the present study has established beyond doubt that achievement of students learning mathematics through programmed instruction is better than the achievement of those who are taught by a teacher through the usual methods of classroom instruction. This result is in conformity with the earlier researches showing the superiority of programmed instruction over conventional method of teaching. The high achievement of programmed instruction group may be traced to the psychological principles involved in the method, viz., individual pacing and immediate reinforcement. Individualised pace of learning, as found by Follettle (1961) and Maccoby and Sheffield (1958), contribute to better learning. Also researches done by Angell (1949), Michael and Maccoby (1953) and Moyer (1963) show that immediate knowledge of results contributes to better learning.

Intelligence along with methods and other learner-characteristics was analysed four times. In all the analyses it was found to affect the achievement scores of students significantly. This result is also in agreement with the generally accepted findings that intelligence is the best predictor of achievement at high school and comparable levels. As there was no significant interaction between intelligence and method of instruction it was confirmed that the two variables affect learning independently of each other. A side analysis, comparing achievement of brilliant students taught by conventional method and students with low intelligence taught by programmed instruction, however, resulted in a highly significant finding. Students with low intelligence and taught by programmed instruction achieved significantly higher than those with high intelligence and taught by conventional method. This shows the extent to which even the lower ability students are helped by immediate knowledge of results provided by programmed instruction. Further, programmed instruction, by virtue of being more analytical, logical and individualised method, and engaging the learner more actively in the task, seems to aid the mental processes involved in learning to the extent that the effect of intelligence is nullified.

The variable introversion is found to significantly affect the achievement scores of the learner. The means of achievement scores for high introverts are higher than those for extraverts, confirming the earlier findings that introverts are better learners than extraverts. This finding is, also, in line with the theoretically understood relationship between introversion and learning, explainable in terms of excitation-inhibition process.

The hypothesis that programmed instruction, being based on conditioning principles, would take better advantage of the process of excitation than the conventional method and thus further enhance the learning process for the introverts was, however, not established as no interaction effect of introversion and method is shown. On the contrary the present results point to the conclusion that extraverts, in whose case excitation is weak, may be stimulated by programmed instruction to the extent that the expected trend of enhanced difference in favour of introverts would not emerge when both the groups are taught by programmed instruction.

Previous achievement in a subject, as universally expected, is shown by the present study to affect the learning outcomes of the students. As regards the differential effect of this variable on achievement through programmed instruction and conventional method, the present study does not yield any significant results. One interesting result, however, that has emerged out, again from the side analyses, is that students poor in previous achievement when taught by programmed instruction score significantly higher than high-previous achievers taught by conventional method. This again is a pointer to the superiority of programmed instruction.

The variable of rigidity-flexibility has been found to have no direct effect on achievement. But the interaction effect of rigidity-flexibility with methods of teaching is significant. It is seen that flexibles when taught through programmed instruction achieve higher than rigids taught by the same method. This trend is reversed when the method of teaching is conventional. The superior achievement of flexibles through programmed instruction, it may be argued, is due to the fact that such persons are ready to adapt themselves in new learning situations, whereas rigids, who are averse to change, find themselves ill at ease while learning through a new method, like programmed instruction. Contrary to expectation, the variable study habits showed no significant effect on achievement either alone or in combination with methods of teaching. The only explanation that can be offered for this negative finding is that programmed instruction being a powerful method of instruction, offsets the effect of study habits.

As for retention, this study shows that students who learn mathematics with programmed instruction retain better than those who are taught by conventional method. These findings are in the expected direction and corroborate the research findings of Desai (1930) and Sharma (1968). The superiority in retention of programmed instruction group may be attributed to the motivational effect of programmed instruction on the learner.

This study also shows that the effect of intelligence, which is generally regarded as the best predictor of achievement, is insignificant in the case of retention of the material learnt. Also, this variable has been found to have no differential effect on retention when combined with any of the two methods.

The main effect of introversion on retention scores of the students is significant in a few cases. The means of retention scores for introvert students are found to be somewhat higher than those for extraverts. This may be explained in terms of introverts resistance to inhibition and the resulting perseveration of learning. Thus, introverts not only achieve higher than extraverts, but also retain better though to a lesser extent. The interaction effect of introversion and methods of teaching has emerged out to be insignificant.

As against no significant effect of study habits on achievement, retention is found to be significantly affected by this variable. The means of retention scores of students having good study habits are higher than those for students having poor study habits. The combined effect of study habits and methods of teaching is, however, negligible.

Rigidity has not been found to be significantly effective in retention of the learned material. However, the mean retention scores for rigids are invariably higher than those for flexibles. Also, this variable has been found to have no effect on retention when combined with any of the two methods of teaching.

The study also shows that previous achievement in mathematics not only influences achievement of the subjects, but also affect their retention. But the interaction effect of methods of teaching and previous attainment in mathematics is insignificant. This shows that methods of teaching and previous attainment influence the phenomenon of retention independently.

The following conclusions may be drawn from the present study:

1. Programmed instruction is a superior and far more effective method and leads to better achievement than conventional classroom teaching.

2. Programmed instruction is a better method not only in relation to achievement but also in relation to retention.

3. The personality dimension of introversion-extraversion has highly significant effect on achievement and some on retention scores of students, introverts being superior to extraverts.

4. Introversion-extraversion when combined with any of the method, has little differential effect on achievement or retention, but introverts with poor study habits achieve better than extraverts with poor study haibts when both are taught through programmed instruction.

5. Intelligence has highly significant effect on achievement, more intelligent students achieving higher than less intelligent students.

6. Intelligence, however, does not exert any influence on retention of the learned material.

7. Intelligence, even when combined with one or the other, of the two methods of teaching does not show any effect on retention of the learner.

8. Students with good study habits retain better than those having poor study habits. This effect, however, does not show up so far as achievement is concerned.

9. The personality variable rigidity affects neither achievement nor retention of students.

10. When rigids and flexibles both are taught through programmed instruction, flexibles achieve higher than rigids. This trend is reversed when teaching happens to be through conventional method.

11. The variable rigidity when combined with methods of teaching does not have any differential effect on retention scores of the students.

12. Previous achievement in mathematics significantly affects achievement and retention scores of the students. The students with high previous attainment achieve and retain higher than those who have poor previous achievement.

13. The combined effect of previous achievement in mathematics and method of teaching is insignificant on both achievement and retention of the learners.

14. Students poor in previous achievement when taught by programmed instruction achieve better than high achievers taught by conventional method.

The educational implications derived from the study are that programmed instruction as a method of teaching can be effectively used with school pupils of varying characteristics and personality descriptions. All the more significant is the implication that pupils with low intelligence and poor study habits can benefit from programmed instruction to the extent that they can achieve even higher than pupils who are better in these characteristics. As such the use of programmed instruction for initial as well as remedial teaching may be unreservedly recommended.

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March, 1981 M.M. SHARMA

C O N T E N T S

Appendix D - Tables 11-20 Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance. XXVI – XXXV

List of Abbreviations

M = Method of teaching

M_1 = Programmed Instruction

M_2 = Conventional classroom method

I = Intelligence

I_1 = High intelligence

I_2 = Low intelligence

A = Previous attainment

A_1 = High previous attainment

A_2 = Low previous attainment

In = Introversion

In_1 = High introversion

In_2 = Low introversion

R = Rigidity

R_1 = High rigidity

R_2 = Low rigidity

S = Study habits

S_1 = Good study habits

S_2 = Poor study habits

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CHAPTER - I

INTRODUCTION

Between the long felt need for a systematic and scientific approach to instruction and its fulfilment, there was a gap that could be bridged only after careful consideration and by considerable efforts. The really big mile stone in this direction came to lime light in the middle fifties of this century with the work of B.F. Skinner, Skinner had been very active in areas related to animal training and made the critical decision to apply his experience to the education of human beings. Thus was born what came to be known as programmed instruction. It was the first systematic and scientifically sound application of technology in the form of machine which taught students by exposing to them programmed instructional material.

Shah and Dewal described Skinner's work as the first revolution in the history of education. According to them "Skinner uprooted the faulty assumption of William James that psychology is a science and teaching is an art, and that sciences can never generate art directly out of themselves" (Shah and Dewal, 1970, p. 7). Skinner, they argue, demonstrated that teaching could also be a science, systematic and accurate like computer sciences.

Skinner regarded learning as creation of new forms of behaviour which was possible by continuous strengthening or reinforcement of small segments of the learner's responses. According to him, as Peel (1963) points out, these relatively minute changes of behaviour are reinforced in a sequence of small steps, each of which builds upon its antecedents. Skinner termed this process as programmed instruction and prepared teaching material based on it. He further explained that programmed instructional material was characterised by making successive steps as small as possible. This raised the frequency of reinforcement to a maximum and the possibility of being wrong and its aversive consequences were reduced to a minimum.

Corey (1967) has given an operational definition of programmed instruction. According to him it is a process whereby the environment of an individual is deliberately manipulated to enable him to learn to emit, or engage in, specific behaviours under specific conditions or give specific responses to specified situations.

Thus programmed instruction has the following steps:

1. The subject matter is arranged logically and broken into small learnerable units (called frames)

2. In each frame the stimulus is presented in the form of a piece of information and a question is posed in relation to it. The learner interacts with the material and gives a response.

3. The response of the learner is reinforced by his knowledge of its correctness. For this he compares his answer with the given answer.

Skinner, thus, developed a well considered science of teaching. He used the language of operant conditioning in describing the learning process, developed self learning material and used simple mechanical devices for presenting the material to the students.

When we carefully consider the principles underlying programmed instruction such as the principle of individualised instruction, of small steps, of logical sequence, and of activity then we cannot credit Skinner alone for its development. Teaching-learning process has been going on since the dawn of civilisation and the above mentioned principles were consciously or unconsciously developed and practised, in some form or other, by eminent educationists and psychologists. Callahan (1973) has pointed out that the claim that experimentation in programmed learning originated during 1950's belies the facts. Individualised form of learning, one aspect of programmed instruction, according to him, began much earlier.

Kulkarni and Kapadia (1974) argue that though the term programmed learning is not a very old one in the field of psychology and education, the concept is "as old as Socrates". Socrates in the Meno taught a slave boy the proof of the Pythagorean theorem by using simple diagrams and leading the boy at his own speed, by small steps, to generalisations of some significance.

HISTORICAL SETTING OF PROGRAMMED INSTRUCTION

The history of programmed instruction can be traced from two stand points i.e. as an auto instructional movement and as the development of the various underlying principles which have helped in the formation of programmed learning concept.

From the first stand point it is a method of presenting the learning material through machines or printed frames and self or mechanical recording of the learner's responses.

The first psychologist who focussed attention on the possibility of teaching through the use of machines was Sidney L. Pressey (1920). Fry (1963) has described the work of Pressey as "recorded patent for educational game device". This 'device' possessed many characteristics of a teaching machine. Pressey produced his first machine in late 1920's at Ohio State University. The machine called for student responses to multiple choice items. The student was required to press buttons placed against responses which were numbered so as to correspond to multiple - choice items. If the correct response was selected and the correct button was pressed, the machine automatically moved to the next question; if an incorrect response was selected, the error was mechanically noted, and displayed on the board and, consequently, the student had to make additional responses until he selected the correct one, pressed the correct button, and thus, moved to the next item.

There were two unique features of Pressey's machine. The first was its simple mechanical arrangement and, secondly, it had a simple attachment that made possible the placing of a reward dial at any desired goal-score which, if attained, automatically resulted in the student getting a candy lonzenge. Thus Pressey, in his machine, made reinforcement immediately and automatically possible not only in the form of a knowledge of correct response but also in the form of a material reward.

It is often pointed out that the machine developed by Pressey emphasised the automation of testing rather than of instruction. Instead of providing information and posing a question for response, it exposed only the question and recorded the errors made by the student or rewarded him for his correct response. Little (1934) for one, has criticised the machine on this point. According to him the machine designed by Pressey was not of much importance or interest, but, because it indicated the possibilities for automation in education, it was of some historical value.

Skinner also did not accept the "Teaching Machine" of Pressey as a teaching device. He described it as a mechanical version of self scoring test form which did not serve the desired purpose of teaching a student; rather the student was presumed to have studied a subject before coming to the machine. By testing himself, he could at best consolidate what he had already learnt.

This, however, cannot be accepted as a valid ground to establish that machine as designed by Pressey had no importance in the development of programmed instruction. His machine incorporated three basic features which were later to be found in all subsequent teaching machines as well as in other programmed instructional material. These were:

1. *The principle of constant active participation by* the learner in the learning activities.

2. Immediate confirmation of the individual's response and reward for his success, and

3. A provision for letting the rate and sometimes the sequences of instruction be determined by the student's own response.

Evaluating Pressey's work Lumsdaine (1964) has commented, "Even though Pressey's devices initially emphasised the automation of testing rather than of instruction, it was evident that they incorporated principles of learning enunciated by psychologists - the major emphasis being on active participation, immediate confirmation and individual progression adapted to the capabilities of individual learners" (p 378).

Following Pressey, his colleagues and students continued to work on the concept of immediate knowledge of results. While giving a brief history of the development of programmed instruction, Corey (1967) has mentioned the names of Peterson, Little, Angel, Troyer and Stephens - all of them being inspired by Pressey's work.

Hans Peterson (1931) with his brother J.C. Peterson devised "chemo-sheets" on which the student checked his choice of answers to multiple choice questions with a swab, finding that wrong answers immediately turned red and the right ones blue.

Pressey, later on in 1932, developed this device into a form of punch board which he called a self instructional and self scoring system. In it the learner punched his pencil through a cover paper against one of several provided answers to a given problem. In case the pencil went deep down, it was an indication that the right answer had been punched.

In another system, Angel and Troyer (1948) placed a red dot at the bottom of the correct hole in a punch board. In case the student punched the correct answer, the punching exposed the red dot, thus indicating the correctness of the answer.

The use of sealed tabs, to be lifted by the student as a part of response, was also made in place of punch board. Glaser, Damrin and Gardner (1954) used tab system for training students in electronics. They built a system in which tabs were used for concealing information required by the student for solving simple problems in electronics. As the student removed each tab (in response to a question), he was given more information about the circuit being studied. The object of this system was to locate the difficulty and to give the student the required information immediately.

The most important break through in the development of programmed instruction and teaching machines, as mentioned earlier, came in the middle fifties with the work of B.F. Skinner. In 1954, Skinner's paper "The science of learning and art of teaching" gave a new impetus to mechanised teaching. Skinner, excited by it, raised the question as to "why the school rooms should be any less mechanised than the kitchens". His question was especially relevant in the modern technological age, when, according to H.G. Wells "Time Machine", by the year 2000 A.D. the world would be completely automated.

The first teaching machine designed by Skinner (1954) was called the "Slider Machine". In this device, used mainly for teaching "Arithmetic and spellings", the student responded to the exposed frame by moving a slider.

Another teaching machine developed by him was "The Disc Type Machine". The principle employed was the same as in the "Slider", but the device was more complex. The machine contained a large paper disc. The programmed material was printed on this disc. The machine had a slot at the top through which frames of programmed instructional material along with relevant questions were exposed. This could be rotated with the help of a lever. The student had to write his answer to the exposed question on a paper tape that was also visible through a slot. After recording the answer he moved the lever which covered the student's response with an opaque glass plate, and exposed the correct response to the question. If the answer was correct the student moved another lever which in turn exposed the next question. The disc could be rotated until the student had answered all the questions. The machine like the "shene sheet" had the added advantage that the student could not erase or change his answer and thus errors were recorded for future reference and for remedial measures. More mechanised versions of Skinner's programmed lessons started to appear with a teaching machine resembling a type writer in 1954. In 1956, Skinner proposed a machine that could be combined with an electronic computer. The computer would store the programme and feed it to the student in a predetermined sequence. The student could respond by using the typewriter connected to the computer. The computer could score the response, inform the student, record the attempt, and proceed to the next question. This materialised in 1958, with the International Business Machine Corporation assembling such a machine which was combined with IBM 650 Digital Computer.

The peak period of teaching machines, thus, starting in 1959, continued during 1960's when the process was almost always computorised. Crowder in 1959 introduced what were called "intrinsic programmes" with his machine "Mark I Auto Tutor" and developed intrinsic programming in other computorised devices. The machine presented frames to the students for study. The student was asked to select the correct answer. When he chose one of the answers, the machine directed him to another of the microfilmed pages in the programme. Thus, the machine gave the learner access to each of the 10,000 pages through an in built mechanism.

Intrinsic (branching) programming, as different from simple (linear) programming, makes provision for the learner to know not only that he is right, or wrong, but also as to why he is wrong, and leads him to right information.

Following these machines a number of audio-visual teaching machines had been devised by the middle of 1960's.

After the first excitement engendered by the hope for mechanisation of instruction, the utility and cost of teaching machines were reviewed. It was generally understood and emphasised that it was not the machine, but the programme in it, which influenced the learning process. Leith (1963) agreeing with this understanding, asserted that the effectiveness of teaching machines depended, above all, on the quality of the programme used.

Thus, from early 1960's another parallel development took place when, along with machines paper pencil devices like books and cards came into use. Although they lacked some of the controls which the machine imposed on the learner, these new devices provided as much flexibility in the rate of learning, sequencing of the subject matter and immediate knowledge of results as the machine. Around this time, the question was raised if the machine was necessary at all. It was argued that the machine was useful because (i) it enhanced motivation, (ii) it prevented cheating, and (iii) it was easier and less fatiguing to use.

In order to compare the outcomes of learning through teaching machines and programmed text books, various researches were done. In a direct comparison of teaching by machine and by programmed text Feldhusen and Birt (1962) found the achievement mean scores to be almost identical. Similarly Busby and Mann (1963) using Min/Max type machine and T.M.I. programme, also taught by flash cards, and by a teacher, found no advantage in favour of any of the methods. Eigen (1962) and

Gotkins and McSweeny (1967) also support these findings.

It was because of these experiments and also high cost of machine fed programmes that the book format of programmed instruction found greater popularity in the late 1960's although machines still continued to fascinate the enthusiasts of programmed instruction.

So far we have been mainly concerned with the technological aspect of programmed instruction. Turning to the principles underlying programmed instruction, we find that reference has to be made to the psychology of learning. Principles of learning evolved by psychologists like Thorndike, Pavlov, and Tylor, to start with, and taken up for further development and refinement by Guthrie, Hull and, above all, Skinner himself form the main theoretical basis of programmed instruction.

The historical development of principles underlying programmed instruction has been reviewed by Dale (1967). He has described some instances in which certain principles and characteristics later incorporated in programmed instruction were central ideas in the earlier efforts of instructional movements. This fact can be traced through many examples. The key factor in programmed instruction is the detailed specification of objectives of instruction in behavioural terms. Prominent among those who emphasised analysis and behavioural specifications are Franklin Bobbit (1924), W.W. Charters (1925), and Ralph W. Tyler (1929). As for the principle of individual pacing of learning experience, another aspect of programmed instruction, it may be found in Mary Ward's plan of work (Corey, 1967) in which she developed self instructional exercises for individual learners.

The most striking event in the history of the development of the underlying principles of programmed instruction may be traced back to Thorndike's discovery of the "Law of effect". Skinner (1954) himself acknowledges this. To quote his own words, "The law of effect has been taken seriously; we made sure that effect does occur under conditions which are optimal for producing the changes called learning" (P. 86).

It may be recalled that Edward Thorndike formulated his second law of learning, viz., "Law of Effect" as follows: "Behaviour that leads to pleasant consequences tends to become stronger; that which leads to unpleasant consequences becomes weaker". According to this law a behaviour form is reinforced by an experience involving success. Skinner links this up with his experiments with animals, which finally proved, in slight deviation from Thorndike, that a stimulus is not necessary for reinforcement of operant behaviour. As Correll (1973) explains "This is in opposition to the earlier works of behaviourist psychologists, Hull and Thorndike, who thought of a reinforcement in the sense of a closer association of stimulus and reaction by success experiences". According to Skinner operant behaviour, if successfully carried out, reinforces the tendency of operant behaviour to repeat itself more frequently. Thus the operant behaviour as conceived by Skinner is a concept which emphasizes that behaviour has an effect on the surrounding world and gives rise to certain consequences.

Skinner, again deviating from Thorndike's formulation of the law of effect, and disagreeing with the view that a man behaves because of consequences which are to follow his behaviour, promulgated that man behaves because of consequences which have followed similar behaviour. The law of effect as exemplified in operant conditioning simply specifies a procedure for altering the probability of a chosen response. Here response is not elicited, but it is emitted by the respondent when the respondent acts upon the environment.

Skinner (1933) conducted some of the most delicate experiments on animals and was able to state precisely the conditions under which an animal would learn. His technique of operant conditioning is one of the most powerful tools ever discovered for controlling the behaviour of animals and men.

In his famous experiment "To make a pigeon turn round clockwise at a given signal", Skinner rewarded each tiny step of the bird in the direction of the desired turn. In this way he succeeded in "educating" his pigeon in a desired form of behaviour within a few minutes time. Kay (1970) has remarked that when Skinner turned to human learning, he found the usual class room situations to be the negation of all the principles he knew to be correct in the laboratory. The pupils made responses, but might have to wait a day or more before being told whether they were correct. The lessons in the class proceeded at a set pace that might be too slow for some and too fast for others. Thus a good number of problems were presented by usual class room teaching for Skinner to tackle.

Skinner applied his technique of operant coordination to humans in class room situations. Correll (1973) points out that the results of those experiments were astonishing, and encouraged Skinner to resort to purely technical aids, "The machines", in order to accelerate the process; from those initial efforts arose his learning programmes and teaching machines.

This shows that for the first time a conscious and systematic application of psychology for teaching purposes was made when Skinner initiated his programmed instructional techniques. Vaidya and Rajput (1977) would go so far as to assert that programmed learning grew out of experiments in operant conditioning of pigeons in Skinnerian laboratory in Harvard University.

Shah and Dewal (1970) have designated the work of Skinner as the "first revolution in the history of education". According to them the Skinnerian model has three features:

(A) Learnable segment of behaviour should be so small that correctness of the response is assured.

(B) The learner should be required to do something i.e. he should be actively involved.

(C) On the appearance of right response, reinforcement in the form of knowledge of result should be given immediately.

The above discussion leads us to the conclusion that programmed instruction is an effective way of teaching. But it does not mean that it has no shortcomings. Peel (1963) has criticised programmed learning on the grounds that the learner may be too strongly dependent upon, and attached to, the overall sequence of reinforcements which constitute the programme. According to him School learning is complete only when the learner is able to generalise and use his learning. In order to ensure this, he suggests testing sessions, involving generalisation and application, to be interpolated at intervals within the particular programmed sequence.

Hillebrand (1971) has criticised Skinner's linear procedure as giving the student the feeling of being led by the hand, and hindering pupils freedom to make an independent effort.

However, Skinner's contribution to class room teaching cannot be denied. On the basis of his experiments he introduced the first and the most effective type of "programme", viz., step by step linear programme, and emphasised the importance of immediate reinforcement in the teaching process. This is the very basis of programmed learning approach, and as claimed by many, the very basis of learning process itself.

Crowder (1959) claiming that individual differences in rate of progress and optimum size of learning steps were not being adequately provided for in Skinnerian programme, came out with what is called "branching programme". As long as the pupil progresses from step to step (frame to frame) it is the same as linear programme. If, however, he fails to progress and makes mistakes the "branching programme" provides for his error to be "explained" to him by additional remedial frames. Crowder (1960) has explained this as a technique of using a student's choice of an answer to a multiple choice question for determining the next material to which he will be exposed.

Apart from the basic psychological principles of operant conditioning being applied in programmed instruction, there were other finer developments that took place during 1960's. Lumsdaine in 1961 and May in 1964 demonstrated the effectiveness of stimulus and response functions of associated pictorial and verbal representation of objects to be learnt by making use of active response on the part of the learner.

The preceding discussion leads to the conclusion that programmed instruction has been developed into its present form by the work of psychologists and educationists through the ages. Prominent among them is Skinner and his theory of learning with its central principle of reinforcement which occurs as follows:

(A) The learner receives immediate reinforcement after each response, or a phased reinforcement can be built into the programmed material;

(B) The subject matter is broken down into very small steps, or learnable segments, which are arranged into logical sequence; and

(C) The learner can complete these steps at his own individual pace.

To quote Sbel (1960) "Programmed Instruction is not only a type of educational material called self instructional programs, it is also a type of teaching technique". This indicates wider application of programmed instruction than often realised. The effectiveness of this type of material or teaching technique in terms of pupil's achievement or time taken to learn the material has been established by several studies. There are a good number of studies involving comparisons of programmed instruction and other methods of instruction.

The first systematically made comparative study of class room teaching and the automatic teaching method with immediate knowledge of result was probably done by Little in 1934. He used a small multiple choice self testing device, with immediate knowledge of result, and for control, a group match with the former on intelligence and previous knowledge taught by the conventional class room method. On a final examination the experimental group achieved higher than the control group. Jensen (1940) performed an experiment in which students did not attend regular class meetings but studied in a laboratory which contained the practice test on Pressey Punch Board Text books; page references were available so that they could check their incorrect responses on the practice tests. Performance of these students in terms of post achievement scores was better than of students attending classes and taught in the traditional manner.

The 1960's and 1970's particularly recorded an unprecedented number of such studies undertaken in an attempt to establish the effectiveness of programmed instruction. Some of these studies which have found programmed instructional material superior to the conventional methods are Stone (1965), Sharma (1968), Shah (1969). Patel (1970), Roebuck (1970), Nagar (1971), Mehta (1973) and Kapadia (1974). In almost all these studies two groups have been studied, one learning through programmed instruction and other through the conventional method, and scores on the post achievement test have been compared.

Schramm (1964) has made a survey of research literature on programmed instruction. He reports that out of 36 comparisons between programmed instruction and conventional class room methods, 18 show no significant superiority for students who worked with programmed material, and one study shows a definite superiority for class room instruction.

Hartley (1972), reviewing 110 studies made in 1960's, comparing programmed instruction with conventional methods, reported that in 41 studies programmed instruction was significantly superior to the other in terms of test results. However, in 54 studies the results did not indicate any significant difference between the two methods, and programmed instructional group did significantly worse in the remaining 15 cases.

In view of the above, one would tend to agree with Stolurow (1969) in that "Researches on programmed instruction leave no doubt that students who use it learn". One would, however, like to go further and say that they do not necessarily always learn better than those who use conventional methods.

Besides these doubts as to the supremacy of programmed instruction, the use of the term "conventional method" has also been severely criticised by some psychologists. Rippey (1960) and Hughes (1975) are of the opinion that if the subject matter is organised logically, it, coupled with a good teacher's participation, should be more effective than good organisation of material without teacher's participation.

Besides, it is argued, the term "conventional method" has been loosely defined. The so called conventional method, as Lumsdaine (1963) points out, means unspecified combination of teacher's presentation of the subject matter and undefined learning activities. Hence with this type of method no definite conclusion can be drawn.

Objection is also raised that almost all the studies have compared the post achievement test scores of the subjects. Pikas (1967), Roebuck (1970) and Shuson (1971) cite evidence which suggests that programmed instruction and class room teaching may emphasize different concepts and consequently, they argue, observed differences are, at least in part, a function of the post-test which reflects the emphasis of one instructional method rather than the other, and in most cases it is that of programmed instruction.

It follows that in experiments designed to compare the relative effectiveness of programmed instruction and classroom teaching, the content covered by the pupils under the two methods should be identical. The general practice strictly followed in programmed instruction is to analyse and arrange the content of the course in a logical order. Once this is done, the content is fixed. This, however, is not so in conventional method. The classroom teacher usually teaches the content given to him by the text books. The approach of teaching - where to introduce a particular concept and which point to give greater emphasis - is entirely his choice. Thus, while a programme can be examined after it has been used, it is not usually possible to scrutinise classroom teaching, and therefore, it cannot be established that the programmed instruction and classroom groups covered the same material with the same approach and to the same depth. Hence, in comparative studies it is doubtful whether assumption of equivalence of content would stand good on a close scrutiny of the details of the methods and material used by the teacher in classroom instruction.

The early assumption that programmed learning will work effectively for all types of students has also been challenged by Dolty and Dolty (1964). They have found a sufficient degree of relationship between achievement through programmed instruction and attitude of the learner and his social needs. Sutler and Reid (1969) also found that students slow in sociability and high in test anxiety achieved better alone, that is, through individualised programmed instruction, than those with the opposite personality characteristics.

Leith (1968) conducted studies for finding out relationship between learning and personality. A general conclusion drawn by him is that learning through programmed instruction and personality are interrelated. Findings by Bhusan and Sharma (1975), and Singh (1977) support this conclusion.

Every human being is a product of a genetic endowment and an environmental history which are peculiarly his own. With this in mind, Fusco (1962) argues that a particular programme may not be optimally effective for a heterogeneous class. An ideal sequence of items for one student may be less effective for another.

Taking a clue from the above mentioned studies and discussions, it was thought worthwhile to study the effect of learner's characteristics on his achievement through programmed instruction as compared to his achievement through classroom method of teaching.

The factors taken for study, along with the two methods, were as under:

1. Intelligence
2. Introversion-Extraversion
3. Rigidity
4. Previous attainment in mathematics.
5. Study habits.

Objections may be raised as to why these, and only these, factors are chosen for study in relation to teaching methods. True that a number of other variables like anxiety, dependence proneness, creativity and level of aspiration could have been meaningfully included. The study had, however, to be delimited to a manageable number of variables. Besides, it is not always possible to get data from the same groups of subjects on a large number of tests etc. The most important reason, however, for selecting these variables was their meaningfulness for the study in hand.

Intelligence:

The relationship between intelligence and academic achievement has long been established beyond doubt. Hence, it has been found necessary to either include or control intelligence in any comparative study of achievement.

The term high intelligence implies those cognitive abilities which help the learner in apprehension of facts and in acquiring learning sets. Intelligent students can quickly synthesize the material, correct mistakes independently, verify solutions, use logical approach and, thus, employ more efficient method of solving a problem. All this helps intelligent student to achieve better than less intelligent students whose cognitive functions are assumed to be less developed.

As far as achievement through programmed instruction is concerned, it is claimed, that, though intelligence is a major factor contributing to academic achievement, programmed instructional method would iron out the effect of intelligence on achievement. To quote Fry (1963) "The early belief that programs and teaching machines might resolve difference in intelligence may seem in-explicable at the present time, yet it rests upon some rather convincing evidence".

Research findings in this regard, as reviewed in Chapter II, however, give conflicting or, at best, inconclusive results and as such pose a problem before psychologists regarding relationship between achievement through programmed instruction and the intelligence of the learner.

The "convincing evidence" which Fry (1963) might have in mind can be gleamed from the following few studies mentioned below.

Little (1934) found that students at the bottom of intelligence scale were helped by teaching machine (Pressey) considerably more than the students at the top when compared on post objective test scores. It is interesting to note, however, that when a final essay examination was given, no difference in the quantum of gain between the top and the bottom groups showed up.

Porter (1959) on the other hand, found that there was no significant relationship between intelligence scores and the achievement of the groups when taught with machines. Another part of Porter's study revealed that there was significant and positive relationship between the two factors when a conventional classroom method was used.

Contrary to this, Shay (1961); Lambert, Miller, and Wiley (1962) in their respective studies found intelligence to be significantly and positively associated with achievement through programmed instruction. Shay, however, compared achievement of low and highly intelligent persons through programmed instruction and not the difference within the same intelligence groups between subjects taught respectively through programmed instruction and classroom method.

Much later, Sharma (1968) found that students with relatively low intelligence achieve better through programmed instruction than conventional method of teaching. It was interesting to note that the difference between the means of less intelligent groups taught by programmed and conventional method respectively was more than between the groups of more intelligent students respectively taught by the two methods.

The findings showing more gain by low intelligence group may be interpreted to indicate that in programmed instruction where the students work at their own optimal pace with sequentially organised or programmed material relatively less intelligent students also go through the same type of cognitive processes as their more intelligent counterparts do by virtue of their higher mental ability.

It may, on the other hand, be argued that the more intelligent students, by very definition of intelligence, will have greater ability to learn from the more systematised experiences provided by the programmed instruction. Their ability to synthesize, apprehend and verify will be at its best when confronted with programmed material. Hence the difference in achievement between the less intelligent and the more intelligent students will remain whatever method is used.

It was in order to examine this possibilities and to clarify the role of intelligence vis a vis programmed instruction that intelligence was included as a factor in the present study.

Introversion-Extraversion:

The dimension of introversion-extraversion is one of the three dimension of personality identified by Eysenck. In his factor analytic studies of data generated with the help of self descriptive inventories and objective tests, the dimension of introversion-extraversion was found to be related to conditionability. Introverts were found to be more easily conditioned than extraverts. In order to explain the relationship between introversion-extraversion and conditionability, Eysenck assumed that this was due to the relative strength of the process of excitation and inhibition. Whereas introverts are quickly excited, extraverts are not so easily excited. The strength and speed of inhibitionary processes in case of introverts and extraverts is such that inhibitory processes are quicker in extraverts than introverts. Thus introverts are easily conditioned because they are easily stimulated, and once they are stimulated the state of stimulation lasts longer. Extraverts, on the other hand, are not so quickly stimulated. Also, the state of stimulation in extraverts is short lived.

Studies conducted by Eysenck and Cookson (1969), and Entwistle and Entwistle (1970) have clearly shown that the dimension of introversion-extraversion is one of the important determinants of academic success. According to their findings, while there is a tendency for introversion to be associated with academic success among older children and students at secondary levels, extraversion is more helpful in academic success at primary levels. Entwistle (1973) also confirms this relationship. Many apparent contradictions in the literature are resolved by the recognition that extraverts tend to be successful in primary schools, while introverts predominate among outstanding students at secondary stage because learning at primary level is based more on social interaction than on purely mental processes. The expectation regarding the differential effect of the dimension of the introversion-extraversion in school learning by the two methods of teaching is derived from the fact that programmed instruction is based on the principles of conditioning. As introverts are more easily conditioned they are more likely to be benefitted by programmed instruction than extraverts. As for the conventional classroom teaching which does not systematically utilize the principle of conditioning, one would not expect that there will be much difference in the performance of the two groups.

Rigidity:

Since programmed learning involves presentation of the subjectmatter step by step and since this type of instruction is systematic and methodical, another personality variable which is likely to have differential effect on academic success of pupils taught by conventional and programmed methods is rigidity.

Although rigidity has been defined in different ways by different investigators, resistance to change or the tendency to perseverate in thinking and response remains the basic feature of all the definitions. For example rigidity has been defined as the inability to change one's set when objective conditions demand it (Rokeach, 1948), "adherence to present performance in an inadequate way" (Goldstein, 1943), lack of variability of response" (Werner, 1946), and "the difficulty with which old established habits may change in the presence of new demands" (Catell, 1949).

All this leads us to expect that this personality variable should have differential effect on acquisition of knowledge under the two kinds of instruction. As pointed out earlier, programmed instruction follows a set procedure, requiring the pupil to pick up one bit of information at a time. Thus pupils exposed to this method of instruction are not obliged to analyse the content, which they would be if exposed to conventional methods of teaching where the material is presented in a more or less integrated form, and the pupil has first to analyse the material and then to understand its main ingredients. Rigid individuals who are prone to accept things as they are presented to them, without bothering to move away from what is obvious and concrete, will find programmed instruction relatively more compatible to their behavioural tendencies and temperament.

As against this, non rigid or flexible pupils may find programmed instruction too mechanical and monotonous and as such may not take interest in it as it gives them little opportunity to look at the material from different angles, to move away from the concrete, to be imaginative and have the pleasure of being involved in cognitive processes of analysis and synthesis.

Since rigidity is found to be one of the components of authoritarian syndrome of personality, the tendency to take for granted any communication from an authority, on the part of rigid individuals may also be of help for them in acquisition of the content when presented in a cut and try manner and the learner is expected to hold it without bothering much for implications and wider significance of the piece meal communication.

As regards the conventional classroom teaching, it is the non-rigid or flexible pupil who is more likely to be benefitted by it. Presentation of material in a molar form, alternative approaches to make a point clear, lack of mechanical and rigid order of presentation of material, opportunity to analyse, synthesize, reinterpret and to move away from what is provided, are some of the features of the conventional instruction which may sustain the interest of non-rigid individuals, and lead to better achievement by them.

Previous Achievement:

While researches on academic achievement have clearly demonstrated that what has been achieved in the past will, to a very large extent, determine what one is likely to achieve at present and in the future, there is every possibility that a change in method of teaching from conventional to programmed instruction would be more helpful to poor achievers than the brighter students. Certain features of programmed instruction may enable the poor student to overcome his deficiencies. In contrast to conventional classroom teaching programmed instruction is more pupil centered i.e., in this method the focus of instruction is the individual rather than the group. This being so, the pupil having specific limitations and facing specific difficulties can overcome these difficulties through programmed instruction. Programmed instruction is analytical in approach and when a weak student is taught by this method he can concentrate on different parts of the lesson bit by bit. Moreover, the individualised pace of programmed instruction is beneficial for those students who are unable to keep pace with rather rapid flow of instruction in the classroom. Besides, in programmed instruction the sequence of presentation of material is arranged with due consideration to its logical sequence. This set and systematic arrangement may enable the poor student to understand what he might have failed to understand when exposed to the conventional method.

Study habits:

It will be just stating a truism to say that students with good study habits will learn better than those with indifferent study habits. Good study habits, it may be argued, will help students to feel secure in their studies and gain self confidence and, thus, will lead to better achievement. Brown and Holtzman (1956) are of the view that study habits might affect the academic performance to a greater extent than other general psychological factors.

Researches comparing performance of students having good study habits with that of students having poor study habits when taught by traditional classroom method are quite a few in number - some of them being those of Young 1956, Chapman 1959, Khan 1960, Brown and Holtzman 1966, Baquer 1965, Pal and Saxena 1970, Pathak 1972. Almost all of these point to the fact that good study habits lead to better achievement.

Although researches in the field of relationship between study habits and programmed instruction are few, and whatever research evidence is available in this regard is not uniform, the general trend of findings shows that students with good study habits and taught through programmed instruction prove themselves superior in achievement to those having good study habits but taught through the traditional method (Eigen and Fedhusen 1963, Lankford 1964, Kulkarni 1969, and Patel 1978). This, again, is what should be expected. Programmed instruction is a self instructional method and students interact with the material to be learnt by giving responses to certain questions and thus learn the subject matter without the help of a teacher. In this context of independent study, students who have good study habits will benefit more from the programmed instructional material than from the conventional method of teaching.

Apart from the more obvious additive effect of a better method and good study habits, there would be an interactional effect of programmed instruction and the different factors which contribute to good study habits.

Wren (1941) while developing study habit inventory included (i) reading and note-taking technique, (ii) habits of concentration, (iii) distribution of time and social relationships in study, and (iv) general habits and attitudes to work, in the list of indices of study habits. Kirshman (1955) also included the above factors in his description of study habits.

Brown and Holtzman (1953) in their study habit scale included items on study methods, motivation for studying and attitudes toward scholastic activities important in the classroom.

Rastogi (1966) while developing an inventory for measuring study habits recognises almost the same factors as the previous authors, but sets them in a reclassified and differently worded manner. His six factors are (i) Ability

(ii) Study habits, (iii) Interest and attitudes, (iv) Techniques of study, (v) Nature and temperament, and (vi) External factors.

Out of the above mentioned factors it may be argued, better techniques of studying and interest and attitude of the learner may find more scope in learning with the help of programmed instruction than with the conventional method. This is because programmed instruction, being self instructional process, requires a proper technique of study like reading and comprehending the subject matter given in the frame, locating the central idea, discriminating between right and wrong responses etc.

The other factors like motivation for studying and habit of concentration would also be expected to have differential effect on learning through programmed instruction. Motivation, as the term denotes exerts its effect by means of a set or expectancy established prior to the act of learning. Learners who learn under such a set are found to be conditioned easily. Programmed instruction provides an impetus to motivation through selecting and connecting responses to be learnt and giving immediate positive reinforcement. This generates a chain of motivation-reinforcement which, in turn leads to better learning. As a chain of motivation is not provided by the usual classroom teaching, it is not so highly effective even in the case of pupils with good study habits.

Habit of concentration would also enhances achievement through programmed instruction as students with better concentration are more attentive to the instructional material and, allowed to work on their own pace, would learn much better through programmed instruction than through the conventional method.

Other factors like ability, habit of study, nature and temperament of the learner, and other external factors may also contribute to achievement through programmed instruction as they would to achievement through the traditional method.

Keeping in view the above discussion, the study habits of the learner were considered to be important factors whose contribution to achievement through programmed instruction would be interesting to study. It was expected that good study habits, and programmed instruction when combined together would enhance the achievement of the learner to a high degree.

Thus the present study proceeded to compare the effectiveness of programmed instruction and the usual classroom methods of teaching in the context of the five characteristics of the learner.

CHAPTER - II

REVIEW OF RELEVANT STUDIES

Inspite of the fact that programmed instruction has a short history, it has made a major break through in the methodology of teaching. It has added momentum to educational research with stress on teaching technique.

In 1954 the programmed instruction movement took shape with the work of B.F. Skinner. A great deal of work has in the meanwhile been done in this field, and a wide variety of programmed instructional material has been developed and is in use not only in countries like U.S.A., U.K. and Canada but also in India.

Although research in Programmed instruction started as early as 1954, research work done in this field gathered momentum since 1959. Schramm's summary of research (1964) has annonated 200 original studies of which according to him, approximately 86% appeared after 1959. To quote this author, "No method of instruction has come into use surrounded by so much research activities" (P.2).

The research literature in this field abounds with reports of studies involving comparison of programmed instruction and other methods of instruction. Some of the studies conducted to compare the effectiveness of programmed instructional technique with that of the so called "traditional" or "conventional" technique are briefly reviewed in the first section of this chapter. A brief discussion on the nature of these experiments and the validity of the conclusions drawn by them is also presented.

Comparative Studies:

Most of the early studies conducted in the field of programmed instruction were comparative studies. The common approach adopted by the investigators was to teach a portion of a subject to two, usually matched, groups of students, one receiving instruction by a teacher and the other learning it with the help of self learning material i.e. programmed instruction. The outcomes of learning were measured in terms of post achievement test scores. The mean scores for these groups were compared for finding out the effectiveness of programmed instruction.

Hughes and Mc.Namara (1961) in their study with maintenance trainees found programmed instruction superior to lecture method on post test scores as well as in terms of time taken for completing the unit. The findings were confirmed by Hough (1962) in another study which showed the teaching machine to be superior to the lecture method in terms of time and number of errors in response.

Wend and Rust (1963) who aimed at economical use of teacher's time introduced machine learning. About two hundred students taking English courses were randomly divided into "machine instruction", "lecture" and "no teaching" groups, each having been stratified into three ability levels on an English proficiency test. The lecture was based on the programme, and made use of slides which were also part of the machine teaching. An insignificant difference was found between machine and lecture taught students. This study underscores the importance of programming, whether the programmed material is machine taught or taught by a teacher.

Around the same time as Went and Rust, Hood and Hayman (1963) also compared achievement of students in a three month course using textbook, "English 2600", which was a programmed course, and conventional teaching, the same content being taught to both the groups. No significant differences were found in the overall comparison between experimental and control groups, but high ability students did significantly better with programmed instruction than with conventional teaching, whereas low ability students did significantly better with conventional teaching. Considerable differences were also found in time required by students of different ability levels to complete the programmed instructional material.

Desai (1968) studied the relative effectiveness of programmed learning material and traditional classroom teaching with a unit of teaching in Gujarati language. She found that the difference between the experimental and control groups was significant at .01 level and was in favour of programmed instruction.

Sharma (1968) compared the programmed method with conventional method in the teaching of algebra in terms of post achievement scores. He also studied relative retention under the two methods with a delayed post test. The subjects were two randomly mixed groups of high, middle and low achievers in algebra drawn from IX class of a school in a rural area. The findings of the study revealed that the achievement of the experimental group taught through programmed method was higher than that of the control group taught by the teacher through the conventional method on the post test.

Flynn (1966) took 80 subjects enrolled in educational psychology course for secondary teachers. He formed two groups experimental and control, each group being further divided into achievers and underachievers. The experimental group learned programmed material for three days with a period of 45 minutes each day. The control group learned the material in a lecture discussion arrangement, also for three days, under the direction of the investigator. It was found that programmed method of instruction yielded significantly greater gains in learning, for identified school achievers, than regular classroom method of instruction. It was also found that under achievers performed equally well on achievement measures regardless of the teaching method employed.

Shah (1968) conducted an elaborate study in the field of programmed learning with a programme in the solving of equations in mathematics for Class VI students. Two experimental groups were set up along with a control group, consisting in all of 90 students. Students in one of the experimental groups learnt independently through programmed learning material, while in the other group a teacher helped the students when they worked on the programme. The control group was taught through the usual classroom method. It was found that the groups taught through programmed instruction did significantly better than conventional lecture group on the post test. However, no significant difference was found between the mean post test scores for the two experimental groups.

Shah (1969) in a subsequent study made the usual comparison between an experimental (programmed instruction) group and a control (conventional classroom) group in some school of Ahmedabad. Auto instructional programmes covering the whole syllabus of Algebra of standard VIII were developed and the experimental group learnt through them. The results of the study showed that (i) the total mean score for the experimental group was higher than the total mean score for the control group; (ii) the order of difference between mean achievement scores with the two methods changed with the previous achievement level and (iii) with some explanations of a few technical terms, students of a much lower standard, i.e. standard V could also learn through the programme easily and could answer the "Self test" given at the end of each unit quite satisfactorily but taking almost double the time to go through the same content as learnt by the student of standard VIII.

Moriber (1969) prepared a three weeks course in physical science. The experiment was carried out on 240 students (non science), with 120 students completing their course through programmed instruction and 120 students, the control group, receiving instruction through lecture-demonstration method. The results indicated that an additional unit in Chemistry could successfully be incorporated in the programmed version of the existing course of study. Also, the level of acquisition of knowledge on immediate testing was significantly greater among subjects receiving programmed instruction when they were compared to control subjects who had attended lecture-demonstration lessons.

Mehta (1973) conducted a similar experiment involving 333 pupils of grade V belonging to six schools in the city of

Baroda. Results showed that students in the programmed instructional group did significantly better than their counterparts in the control group - taught by the teacher - in terms of their scores on an immediate post test.

In studies reported above almost all the findings lead to the conclusion that programmed instruction is more effective than conventional method.

In most of the comparative studies so far discussed experimental and control groups were matched for pre-achievement before the groups were taught by either of the two methods. Roebuck (1970) in his study made a significant variation in the method. He took two groups of students who differed significantly on pre-test scores, the mean of the experimental group being lower than that of the control group. At the conclusion of teaching, the post test mean for the experimental group (taught by programmed instruction) was found to be higher than for the control group (taught by lecture method). Apparently the conclusion is that the programmed instruction group which started below the non programmed instruction group ended up with a higher achievement, and, therefore, programmed instruction is superior.

An analysis of co-variance, however, revealed a significant difference between the regression coefficients showing that the pre-test/post test relationship for the two groups was not of the same nature. The programmed instruction group did achieve better than conventional method in terms of post test scores, but the results of the analysis of covariance may be interpreted to mean that the two methods taught along significantly different lines and emphasised different concepts. A further probe in the method and material of the study revealed that both the pre-test and the post test were based on the programme content as they were supplied by the writer of the programme.

As shown in the above discussions of Roebuck's study, the conclusion drawn by investigators and psychologists regarding greater effectiveness of programmed instructional material is not universal. Doubts have been raised as to whether such conclusions would stand good on a close scrutiny of the details of such experiments. In the first place, all the studies reporting significantly better results for programmed instruction, except Shah (1969) and Mehta (1973), are short term studies. Results based on teaching for a short duration may not provide a solid proof of the effectiveness of a particular method. Sometimes, because of novelty effect of a method, students may get motivated, which in turn may affect their level of learning till novelty is worn out. Also, the commonly used, term "conventional method" is loosely defined. The term, as Lumsdaine (1963) has pointed out, has usually meant some unspecific combination of presentation by some instructor plus, perhaps, some unspecified use of a text or some other study material. Since, in the studies discussed above the very method to be compared is non-specific and non-analytically defined, it does not allow for any meaningful conclusion being drawn about the comparative effectiveness of the other method.

There are some studies in this field which report a finding of "no significant difference". Smith (1962), for example, compared programmed instruction and conventional method with 123 college students acting as subjects. No significant difference was found on the post test scores obtained by the two groups but there was a saving of 30% in time with programmed instruction.

Slaicher in 1964 made an attempt to determine the effectiveness of instruction by a programmed text as opposed to conventional method in a tenth grade plane geometry class. Two groups, one an accelerated class and the other an average class, were selected to use Temac Programmed Text. For control groups one advanced and two average classes were selected. The same teacher taught all control and experimental classes. The teacher was an experienced, competent individual who had no bias in terms of preference of method. Though the control group subjects studied for additional 20 or 30 minutes per day, the experimental subjects completed the course in a shorter period than they did. No significant differences were found on the final test of achievement.

Shah and Krishnamurthy (1974) taught a topic of addition and subtraction of direct number to one group of students of class VIII through programmed instruction while another group learnt the same topic through the traditional method. In their study equivalent groups technique was applied and the pupils in the two groups were matched on the basis of I.Q. The groups were compared after instruction in terms of mean scores obtained on a teacher made test and the difference was found to be insignificant.

There are a number of other studies as for example Hatch and Flint (1962), Feldhusen, Ramharter and Birt (1962), Garcus, Hayman and Johnson (1963), which report a finding of "no significant difference". Such studies give us less information about the methods than those giving a finding of significant difference. Schramm (1964) has recorded 36 researches out of which 19 showed no significant difference when the two groups were tested on the same criterion test. He has criticised these studies as "The numerous experiments on the programmed instruction that do not succeed in disproving the null hypothesis, may, indeed, be proving that no significant difference exists, but the suspicion arises that in many cases the programs are too short, the samples are too small, the measuring instruments are too dull, to pick up differences if they exist. Moreover, it is often very difficult to extrapolate from findings on short program to the conditions of classroom use" (P.2).

Referring to the "no significant difference" studies, and studies showing superiority of programmed instruction, Cheris (1964) has raised doubts regarding the comparison of post-test scores of subjects who worked through a given programmed text with the post test scores of subjects who learned the same material in the usual way. According to him, it is not usually possible to scrutinise classroom teaching, so it cannot be established that the programme and conventional classroom groups covered the same material to the same depth.

Hughes (1975) in his study "Programmed learning and conventional teaching" planned in detail a lesson plan which was memorised by the teacher. One group was taught by this teacher, while another group received instruction through programmed material. Here also every effort was made to make the programmed lessons similar to the classroom instruction. The relative effectiveness of the two methods of instruction was investigated using a post test. The analysis of variance showed that the pupils taught by the teacher had significantly higher measured achievement than the pupils who worked through the programme.

Generalising from a single study is unwise. However, some other researches like Roebuck (1970) discussed earlier, Pikas (1967) and Bhusan (1971) have also given evidence which suggests that programmed instruction and classroom teaching may emphasize different concepts. They also observed that differences usually obtained between the experimental and the control groups are a function of the post test which is usually prepared on the lines of programmed instruction. When the teacher also teaches on the same lines, the measured difference disappears, or the teacher taught programmed lesson leads to better achievement than the lesson taught through programmed instructional material.

Hartley (1972) compiled 110 comparative studies out of which 18 studies demonstrated that students taught by programmed instruction did significantly worse than those taught by usual methods of teaching. This, again, leads to the conclusion that, on the one hand the term conventional methods needs proper analysis and examination and, on the other, the quality of programmed instructional material has also to be checked and evaluated.

Supporters of programmed instruction, on the other hand, advocate it's supremacy and emphasize researches other than comparative studies. Smith and Moore (1962) are of the opinion that comparative studies done so far sufficiently prove efficacy and effectiveness of programmed instruction. Though many studies have reported no significant difference, others, in their assessment, prove that programmed instruction can teach at least as well as if not better than, a human teacher. Hence, instead of comparing programmed instruction with other methods of teaching, they argue, it should be studied in relation to some other variables.

Intelligence:

One important factor which has attracted much attention in the field of teaching and learning is intelligence. Intelligence test scores have been found to be fairly good predictors of success at high school and comparable levels. Super (1949) pointed out that there exists a positive relationship between intelligence and educational achievement. Jordon (1933), Thurstone (1925), Toops (1923), Mc Phail (1927), Edds & Mc Call (1933), Eysenck (1947), and Harper (1967) have also reported significant correlation (ranging from .315 to .6) between intelligence and scholastic success.

There have been still higher figures of correlation reported by other researches. Wolking (1955), Shinn (1956), Wellman (1957), Edwards and Tyler (1965) have found correlation of .7 and Carter (1950) found a correlation of .78 between I.Q. and measures of achievement in schools.

Stephens (1960), however, asserts that the wide range of correlation (from 0.1 to 0.9) between intelligence and achievement stands testimony to the fact that the problem of genuine correlation between these two variables has not been solved in a conclusive way.

Carroll (1943) concludes from research findings that the bond between mental ability and academic achievement appears to be smaller than is usually assumed. The reason for significant correlation between verbal tests of intelligence and scholastic achievement may be, in his opinion, due to the common underlying linguistic factors.

In the context of this doubt with regard to a direct positive relationship between intelligence and scholastic achievement it is often argued that all students irrespective of differences in intelligence may learn equally well through programmed instruction. As presumed by some researchers, the technique of programmed instruction in its operation totally wipes the difference of intelligence among the students (Cf discussion of Fry - 1963 - in Chapter I, pp 25).

When the researches in this regard are reviewed, we do find some studies which show that the differences between achievement of highly intelligent and low intelligence groups are minimised when they are taught by programmed instruction. It, therefore, appears interesting and useful to determine the worth of such claims by examining research evidence in this regard.

Glaser, Robert and Reynolds (1962) studied the relationship between achievement through programmed instruction and intelligence. They taught 75 junior high school students with a linear general science programme with 1,290 frames and concluded that intelligence measures might not be as predictive of learning resulting from programmed sequence as they were of learning acquired by other instructional methods.

Feldhusen and Bigen (1963) studied interrelationships among attitude, achievement, reading, intelligence and transfer variables in programmed instruction. In the study twenty four 9th graders, twenty three 10th graders and twenty five 11th graders were taught sets-relations and functions by a linear programme. The technique of analysis of variance was applied to analyse the data. Results showed that in none of the groups I.Q. was the fundamental learner variable in achievement.

Shah (1964) developed a programme on solving of equations and evaluated it against the conventional method. She took three sections of class VI out of which two were taught by programmed instruction. She found programmed instruction equally effective for all ability groups. No significant interaction between treatment and ability was found.

Desai (1966) attempted to adopt the technique of programmed instruction in the teaching of Gujarati and studied its effectiveness. She taught 40 students by programmed instruction and an equal number of properly matched students by conventional method. The findings of the study revealed that the difference between the means of the experimental and control groups were significant at .01 level. The programmed learning approach was more effective than conventional teaching approach for students ranging from high I.Q's to low I.Q's, but differences in intelligence did not have any differential impact on achievement through programmed instruction.

Nagar (1971) compared three different measures of learning, viz., recall, retention and utilisation, obtained separately under two instructional treatments viz., Herbartian method and programmed instruction of linear style. It was found that the main effects of intelligence, and the two methods of teaching were highly significant. The two factor interactions of intelligence and methods of teaching were, however, not significant, showing that intelligence did not play a differential role in achievement through the two methods.

Kapadia (1972) in his study found the product moment coefficient of correlation between intelligence and achievement through programmed instruction to be .45, which was significant at .01 level. However, no significant difference was found between mean achievement scores of students belonging to low intelligence group and those belonging to high intelligence group. It was concluded that although there was a significant relationship between intelligence and achievement, intelligence might not be taken as a factor causing difference in achievement through programmed learning.

The studies discussed above reveal that programmed instruction, most probably by virtue of its step by step presentation of material and by accommodating individual differences in the rate of learning helps students of lower intelligence to achieve to the maximum of their ability so that the difference between high and low intelligence groups is minimised. Programmed instruction because of individual pacing of the lesson may mitigate the difficulty of slow speed learners and thus help such students to achieve almost equal to highly intelligent students. This has been further supported when difference between pre-achievement test and post achievement test i.e. gain in achievement has been taken into account by a few researches mentioned below.

Pandya (1974) taught Physics to IX class students with programmed instruction. She compared gains in criterion scores of 20 students of high I.Q. with equal number of low I.Q. students. The latter gained more than the students with high I.Q., the difference being significant at .01 level. The sample was, however, too small for the findings to be generalised. Sharma (1968) in his study discussed in Chapter I also found similar results. Comparable trends have been reported by Porter (1959) but his findings were statistically insignificant.

All the three studies mentioned above indicated a new trend in research on programmed instruction. Instead of comparing achievement scores directly, if gain in achievement in terms of difference between pre test and post test is considered, the low I.Q. students are found to benefit more than high I.Q. students.

This, however, in no way means that low ability students have been found to achieve more than high ability students when taught by programmed instruction.

The positive effect of intelligence on achievement is demonstrated among others, by Shay (1961) who, experimenting with ninety fourth grade students, taught Roman numerals by means of programmed instruction with large, medium and small, programmed steps. He found that intelligence was positively related to the post test scores at .01 level of significance with all the three kinds of programming.

Silberman in a similar study in 1961 found that there was a positive and significant relationship between measured intelligence and amount of learning when high school students were taught logical relationships with a 400 item programme using multiple choice items.

Reed and Hayman (1962) reported that high ability learners did better with programmed instruction, while low ability students did better with conventional method rather than programmed instruction, the latter finding being somewhat away from findings of similar studies. He made a follow up study and found that more intelligent students obtained higher retention scores on two tests (with intervals of 3 to 30 weeks) than less intelligent students.

Lambert, Miller and Wiley (1962) studied the effect of overt and covert response modes, and levels of intelligence on a sample of 332 ninth grade students. A linear programme on sets having 904 frames, was used for instruction. It was found that intelligence was significantly associated with amount of information as expressed by either kind of response.

Thomas (1970) in a pilot research evaluated a linear programme on "Electricity" internally by the criteria of error rate, time taken and attitudes of the learners. External evaluation was effected by comparison with test results from a matched group of junior school children taught the same syllabus in a conventional manner by a teacher. Later, in a large scale study, a programme on "Water" was added to the "Electricity" programme. Both, "Electricity" and "Water" programmes contained an extended sequence of practical experiments, employing performance material, carried out by children in three junior schools. Evaluation was then again made by comparison with conventional teaching of matched groups of children in each of the three schools. Additionally, five other unmatched classes, in four other schools, acted as extra control groups.

Results of these studies showed that in comparison with conventional teaching, the programmes tended to save time and led to atleast equal, often superior, test gains. Positive correlation of attainment with I.Q. and reading age occurred repeatedly for both treatments but there was no general tendency for the correlation in control classes to be higher than those for programmed instructional groups. Those results, again, point to the fact that achievement by programmed instruction is as much affected by intelligence as achievement by conventional methods of teaching.

Bhusan and Sharma (1975) studied the effect of three instructional strategies, namely, traditional method, programmed instruction, and programmed instruction followed by lecture, on the performance of B.Ed. student teachers of different intelligence levels. It was found that programmed instruction supported by lecture method resulted in highest performance when compared with other treatments uniformly for above average, average and below average intelligence groups. Out of the remaining treatments, lecture method and programmed instruction, the latter was found superior to the former, again for all the three I.Q. groups.

Sansawal (1978) studied the relationship of student's characteristics like intelligence, academic motivation and comprehension with achievement through programmed instruction. The sample of his study comprised of 76 B.Ed. students. The topic "Research methodology" was taught to these students by programmed instruction. The mean achievement score of students belonging to high intelligence group was found significantly higher than the means for average and low intelligence groups.

Singh (1977) made a deeper probe by utilising linear and branching programmed instructional material for finding out the relationship between intelligence and achievement through programmed instructional methods. He took three groups of VII class (N=120), each consisting of high, low and medium intelligence matched on Jalota's Group Intelligence Test. These groups were taught the topic of "Accurate arithmetic" by linear, branching and conventional programmes. Significance of differences between means of achievement scores obtained by groups of students taught by the three methods in each of the three strata of intelligence were computed. The branching programme was found to be superior to the linear for both high and medium intelligence students. Branching programme was also found superior to conventional method for high I.Q. but not for medium I.Q. groups. Linear programme was found to be inferior for high and medium I.Q. groups but better for low I.Q. group. The findings of this study lead to the conclusion that achievement through programmed instruction is a function not only of intelligence but also of interaction between level of intelligence and methods of teaching.

The above discussion show that claims and counter claims regarding relationship between intelligence and achievement through programmed instruction have been made by various researchers. Researches done by Glaser and Reynold (1962), Feldhusen and Eigen (1963), Desai (1966), Nagar (1971), Kapadia (1972) and Govinda (1976) have demonstrated that difference between achievement of high intelligence and low intelligence students is minimised by programmed instruction. Porter (1959), Sharma (1968) and Pandya (1974) have shown greater gain in achievement for low intelligence students than for highly intelligent students, when scores on pre test and post test are compared.

Contrary to this Silberman (1961), Reed and Hayman (1962), Lambert, Miller and Wiley (1962), Thomas (1970), Dhusan and Sharma (1975) and Sansawal (1978) have found achievement of high I.Q. students to be greater than that of low I.Q. students whether taught by programmed instruction or conventional methods of teaching.

Research evidences regarding relationship between intelligence and achievement through programmed instruction are, thus, inconclusive and the question need further as well as deeper probe.

Personality Variables:

While one is looking for differences in achievement not quite explicable by differences in intelligence, one obviously thinks of differences in personality for a possible source of influence. Although Fry (1963) deplored that learning theory had taken little account of differences in personality characteristics, there are studies dating back to early 1950's which investigated into differences in attainment based on personality variables.

Personality variables mostly studied and, hence, discussed here in relation to achievement through programmed instruction and conventional methods are as follows:

1. Anxiety
2. Achievement motivation
3. Creativity
4. Introversion-Extraversion
5. Rigidity-Flexibility

Anxiety:

Anxiety has been defined by Sullivan (1948) as a reflection of internal discomfort, and Ausubel (1954) describes anxious students as having unpleasant subjective feeling involving expectation, indefiniteness and a sense of helplessness. At the same time anxious students have been found to be sensitive to stimuli and low in ego strength. Spence and Taylor (1951) have suggested that anxiety plays a very important role in learning. A high level of anxiety facilitates simple learning, but when the level of anxiety crosses an optimal point it hampers complex learning.

Smith (1955), found that students with high anxiety and low initial achievement, gained more on achievement test and were more highly satisfied in a team-work class than in conventional lecture. Dowaliby and Schumers (1973) report findings more or less in lines with those of Smith. They taught two groups of students respectively by teacher centred (Lecture) and student centred (discussion) methods. They found a significant relationship between manifest anxiety and methods of teaching. The teacher centred method resulted in better learning for high anxious students, and the student centred approach resulted in superior performance for low anxious students. Crime and Allmismith (1961) concluded from their research that anxious children performed less well in unstructured than in structured environment.

Studies have also been made in relation to programmed instruction and anxiety. Knight and Sarsenath (1966) taught 139 undergraduate students with a linear programme on "Test construction". They found that anxious student worked faster and made fewer errors than less anxious students. There were, however, no achievement differences between anxiety groups.

Flynn and Morgan (1966) found similar results while studying the relationship between learner anxiety and achievement through programmed instruction. Elementary school students were divided into two matched groups on the basis of intelligence. One group of students learned the material through programmed instruction while the other group of students was instructed by the teacher. Provisions were made to ensure uniformity of subject matter for all classes. A 2 x 3 analysis of variance revealed no significant main effect; the interaction between anxiety and instructional mode was also not significant.

Lacho (1967) found no achievement differences among three anxiety groups and four response modes to a vocabulary programmed instruction for 8th grade students. The response modes studied were constructed response, optimal constructed response, covert response and reading condition. Three anxiety groups were established on the basis of TASC scores. The anxiety and response mode variables were not found to interact.

Davis and Leith (1967) taught "Logarithms" to high school students through programmed instruction devised by J. Hartley. They included anxiety among other major determinants of learning. The relationship between achievement and anxiety was found to be insignificant.

Ripple (1969) studied interaction between anxiety scores and achievement through programmed instruction in a year long study involving 1100 VIII class students from 22 schools, equated on intelligence and sex and assigned to either programmed or conventional instruction. No significant interaction was found between anxiety and achievement through programmed instruction.

Apart from studies which reveal no significant difference in achievement through programmed instruction between anxious and non-anxious students, there are a few studies which have found the achievement of non-anxious students to be higher than anxious students when left alone to cope with the task of learning through programmed material. This may presumably be the result of unpleasant subjective feeling and sense of helplessness which retard the progress of anxious students when taught through programmed instruction.

O'Reilly and Ripple (1967) found a correlation of -.53 between achievement on a linear programme dealing with "longitude and latitude", and test anxiety as measured by Sarson's Test Anxiety Scale for children. Sixth grade youngsters served as subjects in this study. In a stepwise multiple regression analysis, this impressive correlation dropped to a much less impressive degree of -.125, which, while still significant, is very low. The results, however, showed that non-anxious students achieved more through programmed instruction than anxious student.

Kapadia (1972) taught 323 pupils of VIII class two topics, one by linear programme and the other by branching programme. It was found that anxiety was negatively related to achievement on the linear programme. There was, however, no significant relationship between anxiety and achievement on branching programme, presumably because anxious students partialed out learning difficulties with the help of branching programme which in turn minimised the gap between achievement of high and low anxious students.

Seeban and Hambleton (1977) taught IV grade students through programmed instruction and compared them with students who had undergone teacher directed instruction. It was found that the performance of students on programmed instruction was affected by anxiety. The less anxious student scored much higher than highly anxious students through programmed instruction.

Contrary to the above studies which show high achievement for low anxiety students there are a few studies which report that achievement of anxious students through programmed instruction is higher than of low anxiety students.

Traweek (1964) studied the relationship between some personality variables and achievement through programmed instruction. He found that withdrawn, less self reliant students with signs of test anxiety achieved better when taught by programmed learning method as compared with conventional method.

Patel (1979) taught VIII class students some units of geometry with programmed instruction. He found that students with good study habits, greater anxiety and higher need achievement proved themselves superior in achievement when taught through auto instructional programmes than when taught through the traditional method. Thus, research evidence on the relationship between achievement through programmed instruction and anxiety has also remained inconclusive.

Achievement Motivation:

According to Murray (1938) need achievement or achievement motivation means a tendency to overcome obstacles, to exercise power, to strive for some thing difficult and to achieve or get it as quickly as possible. This is an important need of the learner which activates him to know and be able to solve the problem in hand.

The question has been raised whether individual differences in need-achievement scores predict differences in the level of performance. The first study to present unambiguous evidence that the measure of need achievement, as a valid measure of individual differences in strength of motivation, did predict achievement was conducted by Lowell (1952). He found that persons having high need achievement scored higher on both an arithmetic and a verbal task than persons having low need achievement.

Bhatnagar (1967) made a study of the relationship between academic achievement and some personality variables including need achievement. A sample of 912 students reading in IX standard (Commerce) were given Hindi version of EPPS for finding out personality needs. It was found that the need for achievement correlated positively with academic achievement.

Singh (1965) worked on some non-intellectual correlates of academic achievement. The study was conducted on a sample of 370 male students of graduate courses in two colleges of Patna. The means of the aggregate marks in previous three examinations were used as a measure of achievement. Product moment and partial correlations, and correlation-ratio in addition to student-ratio, and chi-square were used to analyse the relationship. The study revealed that academic achievement was significantly and positively related to academic motivation.

Turning to programmed instruction there are very few studies which show positive effect of achievement motivation on achievement through programmed instruction. These comprise studies made by Knight and Sarsenath (1966) and Patel (1978). Both these studies showed that high achievement motivated students learned more effectively, and scored higher with programmed instruction than low achievement motivated students. A number of other studies, however, indicate that programmed instruction minimises the difference between achievements of high and low achievement motivated students.

Doty and Doty (1964) studied effectiveness of programmed instruction in relation to student characteristics including achievement motivation. The subjects of the study were 100 college undergraduates. Programmed instructional material comprising 1507 frames on physiological psychology was given to them. Product moment correlations between each of the student characteristics and achievement through programmed instructions was computed. No significant correlation was obtained between need-achievement scores and scores on a post test based on programmed instructions.

Govinda (1976) studied the relationship between achievement through programmed instruction and achievement motivation with a group of secondary school students. The statistical techniques employed were rank correlation, product moment correlation, chi square and time series analysis. The study revealed that achievement motivation had no definite effect on achievement through programmed instruction.

Kuruvilla (1977) also reports similar findings. The population under study consisted of VIII standard student of English medium schools of Baroda. Three schools were selected randomly and all the 301 students of VIII standard in these schools were divided into four groups. Students in different groups were respectively taught by linear overt, branching, skip and response prompt varieties of programmed instruction. The data were analysed by the analysis of variance, t test, percentile, partial correlations and product moment correlation. It was found that there was no significant relationship between academic motivation and performance of students on a post test based on linear overt, branching and response prompt forms, but skip programme had, a positively significant relationship with achievement motivation.

Soohan (1977) taught 238 students of IX class by programmed instruction. The result revealed that there was no significant relationship between academic motivation and achievement through programmed instruction.

Sanswal (1978) taught a research methodology course to 70 M.Ed. students with the help of programmed instruction. Junior Index of Motivation Scale was used to measure academic motivation. It was found that mean achievement scores of students of high, average and low academic motivation groups did not differ significantly.

Thus, research findings with regard to effect on achievement of achievement motivation in relation to programmed instruction are as conflicting and inconclusive as with regard to the effect of other learner characteristics discussed above.

Creativity:

Torrance (1966) explains creativity as "a process of becoming sensitive to problems, deficiencies, gaps in knowledge missing elements, disharmonies, and so on: identifying: difficulties: searching for solutions, making guesses or formulating hypotheses about the deficiencies, testing and retesting these hypotheses and possibly modifying and retesting them: and finally communicating the results" (P.6). As programmed instruction presents well sequenced material in pre-planned situations, it has sometimes been presumed that creatives who are original in thinking and prefer their own solutions may not perform so well through this method as the less creative students. Gotkin and Massa in 1963 reported that from amongst highly intelligent pupils who had worked through an extensive series of programmes on language skills, it was the less creative students who made significantly greater achievement in terms of gains on post test.

Tobias (1969) findings are contrary to this. He taught a programmed course on "Incidence and gravity of heart diseases" to a sample of 100 college students. The effectiveness of the independent variables was analysed by 2 x 2 x 3 analysis of variance. Results showed that creative students learned more on constructed-response material, i.e. linear programme than the non-creative students. Dotty in 1964 arrived at similar conclusions.

Researches in this field are, however, few and far between and no conclusion may be drawn from such sparse evidence. Creativity being a complex phenomenon the question of its relationship with method of teaching requires elaborate research in order for any conclusive evidence to be arrived at.

Introversion-Extraversion:

As indicated by research evidences introverts have better ability to synthesize and analyse the learning material than extraverts. Researches by Furneaux (1958) and Broadbent (1958) found that high attainers among university students were significantly more neurotic and introverted than low attainers.

Kelvin (1965) and his co-workers also confirmed the superiority of the "neurotic-introverts" in learning and found that a group of student failures tended to be "neurotic extraverts".

At secondary stage level, Entwistle and Cunnigham (1968), and Eysenck and Cookson (1969) have found the relationship between extraversion-introversion and achievement to be more complex and apparently sex linked. According to their findings introverted boys and extraverted girls were better in attainment. Finlayson (1970) also reported that introversion increasingly favoured the performance of boys in Grammer Schools.

Rowell and Renner (1975) studied the relationship between achievement and introversion-extraversion thoroughly and reported that introverts were more successful in structured courses and extraverts in relatively unstructured ones. Studies by Lavin (1965), Entwistle and Brennan (1971), Entwistle (1972) and Fuchs and Meadows (1976) have described high achievers as essentially stable introverts.

The above researches on the whole indicate that introversion is conducive to high academic achievement.

Leith and Davis (1966) studied the influence of social reinforcement and personality in terms of introversion-extraversion on achievement through programmed instruction in a school learning task. Three levels of verbal reinforcement-positive, neutral and negative were administered in a standardised form to 30 children of 13 years of age in each of the four schools selected for the study. Two of these schools were situated in a slum environment and two had a good socio-economic environment. The overall results show that positive reinforcement was better than neutral, and neutral was better than negative reinforcement. There was no interaction between personality type and type of reinforcement but anxious introverts were significantly the best group in terms of achievement.

Davis and Leith (1968) in another study gave programmed instruction on "Logarithm" to secondary school students.

Pearson's product moment coefficient of correlation between achievement through programmed instruction and extraversion was found to be -.192 which was significant at .05 level. This again confirms their earlier finding that achievement through programmed instruction and introversion are significantly related.

Leith Later (1973), studied the relationship between introversion-extraversion and achievement through different methods of teaching. He found that introverts were more successful when they learnt through a carefully sequenced and highly prompted structure of learning (e.g. linear programme), and extraverts learned better in a less formal discovery situation. According to him " - - - - extraverts have a greater tolerance for ambiguity and lack of structure in the teaching situation, whereas introverts are more inclined to be responsive to unambiguous and clearly structured situation". This finding is in line with the findings of Rowell and Renner (1975) who demonstrated that extraverts benefitted more from unstructured courses and introverts from structured ones.

Apart from the studies which report a significant relationship between achievement through programmed instruction and introversion, there are a few studies which have shown that programmed instruction minimises the difference in achievement of extraverts and introverts. These findings have been taken to mean that programmed instruction may iron out the effect of introversion-extraversion on the level of achievement, as it has been often found to do in the case of intelligence. One such study was that of Kapadia. He in 1972 studied the relationship between achievement through programmed instruction and certain personality variables including introversion-extraversion. He taught 535 VIII class student with linear and branching programmes. Partial correlations of the third order were computed between each of the personality variables and achievement when rest of the personality variables were partialled out. No significant relationship was found between introversion and achievement.

Trown and Leith (1975), also studied the relationship between some personality characteristics (anxiety and extraversion-introversion) and two strategies of teaching - an inductive (learner centred) exploratory strategy and a deductive (teacher centred) supportive strategy. There was no evidence of relationship between strategy and extraversion-introversion. Similar results have been reported by Bhusan (1971) and Gosain (1977).

The above review of researches indicates clearly that there are many unanswered questions regarding relationship between achievement through programmed instruction and extraversion-introversion. The findings so far reported in this connection are limited in number as well as lacking in agreement. Hence further research is needed to probe this area rather deeply.

Rigidity-Flexibility:

The term rigidity refers to ways of thinking and behaving which are not responding enough to changes in the demands and conditions of the environment. Rigidity is also termed as mental inertia. Its basic feature is resistance to change or tendency to perseverate in thinking and response.

Rigidity in relation to achievement is a field of research yet to be explored. The present investigator has been able to locate only one research study which can only remotely be considered to fall in this area. Mc Collogh and Attai (1958) reported that students who were less rigid or less in need of social support tended to benefit more from independent study than those students who were more rigid and in need of social support. However, no research directly studying the relationship between achievement through programmed instruction and rigidity is so far available. Hence this field requires a probe by researchers who are interested in studying relationship between methods of teaching and personality variables.

Previous Achievement:

Psychologists, differ in the emphasis they place on the importance of prior learning in subsequent achievement. The learning experiences acquired by a student and new experiences he is going to acquire through subsequent learning have, however, been shown by many psychologists to bear a close relationship. Haggerty (1941) and Townsend (1951) have demonstrated a high relationship between previous and later achievement. According to these authors, after Grade V or VI, the correlations between these two sequential achievements are rarely less than .80. So far as relationship between previous achievement and achievement through programmed instruction is concerned, some researches have been made which are as follows.

Tobin and Ingber (1976) in a short term study used a linear programmed instruction, with 37 frames, to find out the effect of previous achievement on learning. To one group of students this programme was given and another matched group was taught through reading version of programmed material. It was found that pre test scores had a significant relationship with the post test scores. The correlation between these two variables was .94. Interaction between pre-test and mode of responding was significant in favour of programmed instruction. This finding is supported by the results arrived at by Blyth, Godcharles and Liedke (1964), James (1972) and Sheehan and Hambleton (1977) all of whom found that most of the variance of the post test administered after programmed instruction could be attributed to the initial level of achievement.

Noble (1969) studied the relationship between ability, performance, attitudes, inclinations and speed of progress of six groups of children from four secondary schools. He taught mathematics to these students through intrinsic programme. The high loadings of both pre- and post test suggest that programmed instruction was best suited to those who were mathematically able as shown by the pre test.

Apart from the studies which have found positive relationship between previous achievement and post achievement scores, there is one research by Bhusan (1973) which reports no significant relationship between the two variables. He in an experimental study relating to the learning of educational statistics by B.Ed. students through programmed instruction found that the initial level of achievement in mathematics was not significantly correlated with the post test scores.

The foregoing review of researches regarding the relationship between prior-learning and achievement through programmed instruction does not help in arriving at a definite conclusion in this regard. Almost all the studies are of short duration and tools used for measuring previous attainment are not very reliable, as they are usually not standardised.

Study Habits:

There is much controversy regarding the value of study habits in the prediction of academic success. A review of researches for establishing relationship between study habits and academic achievement is presented below.

Young (1952) held that study habits play a significant role in scholarship as they often reflect student's interest and motivation. Improvement of study habits not only helps in the promotion of better work but also influences students' morale and sense of satisfaction. Brown and Holtzman (1964) and Srivastava (1967) also agree that for good academic success good study habits and attitudes are important. Authors like Michael et al. (1957), however, do not favour the use of study habit inventory for the prediction of scholastic success.

Researches in the field show that evidence of relationship between achievement and study habits is not uniform. Parvis (1957) obtained a correlation of .257 between first term grades and study habit scores whereas Januar (1958) reported a correlation coefficient of .51. Chapman (1959) compared underachievers and overachievers and found that the former differed significantly from the latter with regard to the number of academic interests and efficient study habits. Girija, Bhadra and Ameerjan (1975) also found a high degree of correlation between study skills and academic achievement.

A few researches have been conducted for finding out the relationship between study habits and achievement through programmed instruction. Gigen and Fedhusen (1963) for example, found that good reading ability was a good predictor of successful performance on tests following programmed instruction.

Lankford (1964) investigating the relationship between study habits and achievement through programmed instruction arrived at similar findings.

Patel (1978) carried out an investigation with seven pairs of equivalent VIII class groups from fourteen schools. One group from each pair learned the subject matter through programmed instruction whereas the other (control group) learned it through traditional method. It was found that students with good study habits and taught through programmed instruction turned out to be superior in achievement to the students having good study habits and taught by traditional method. Thus programmed instruction was found to be more effective than the traditional method for the students having good study habits.

The mean achievement scores of students having poor study habits, from both the experimental and the control groups, were also compared with a view to seeing whether poor study habits affected adversely learning through programmed instruction. The mean difference between these groups was highly significant the higher mean being for the programmed instruction group. This led to the conclusion that the students having poor study habits also benefitted much from learning through programmed instruction.

Stone (1965) also explored the relationship between achievement through programmed instruction and study habits of the students. The control group students studied a portion of psychology course through the conventional method whereas an experimental group used programmed instruction for learning the same material. It was found that study habits yielded no differential effects on performances under two modes of instruction.

The above review of research indicates clearly that there are many unanswered questions regarding programmed learning and individual differences in the learner characteristics. The facts and findings related to the relationship between achievement through programmed learning material on the one hand and intelligence, previous attainment, introversion, rigidity and study habits, on the other, are conflicting. This points to a need for more extensive research in the area of relationship between achievement through programmed instruction and learner characteristics.

CHAPTER - III

DEVELOPMENT OF PROGRAMMED INSTRUCTIONAL MATERIAL

According to Lumsdaine (1964), a programmed lesson tries to see to it that the student does learn, and it takes the blame for the student's failure. In this way programme is the actual instruction. The student's success or failure depends upon it. Hence a programme should be planned and developed very carefully. Lange (1967) points out that the uniqueness and strength of programmed instruction lies mainly in its production process, but he doubts if any standardised production process of developing programmed material exists. Nevertheless, this process includes a few sequential steps like selection of the topic, specification of behaviour already learnt and to be learnt, frame writing and individual testing, editing of the programme and its validation, which provide a frame work for the programme developer to work with.

Selection of Topic:

As the present study aimed at determining the efficacy of programmed instruction in the teaching of mathematics, it was necessary to select a topic for programming the instruction. For this purpose "Set Theory" in Algebra was choosen. The reason for the choice of the topic was that the population under study had not already studied it. Set theory had never been taught to them previously. Also, the knowledge of set theory could be utilised by the students in solving various problems of different branches of science like Physics, Chemistry and Mathematics which they were studying.

The investigator could have adopted a programme for the present investigation and this would have meant less work but no good programme was available, which could be considered suitable for the present population. Besides, as Kapadia and and Kulkarni (1974) point out, the programmed materials that have been developed in India since 1963 and are available for use are fragmentary in nature and the validation data in most of the cases are not sufficiently reliable.

The programme text on set theory for use in the present study was developed following the usual steps prescribed, viz., task analysis, defining entering and terminal behaviours, writing frames, using prompts, evaluation and revision.

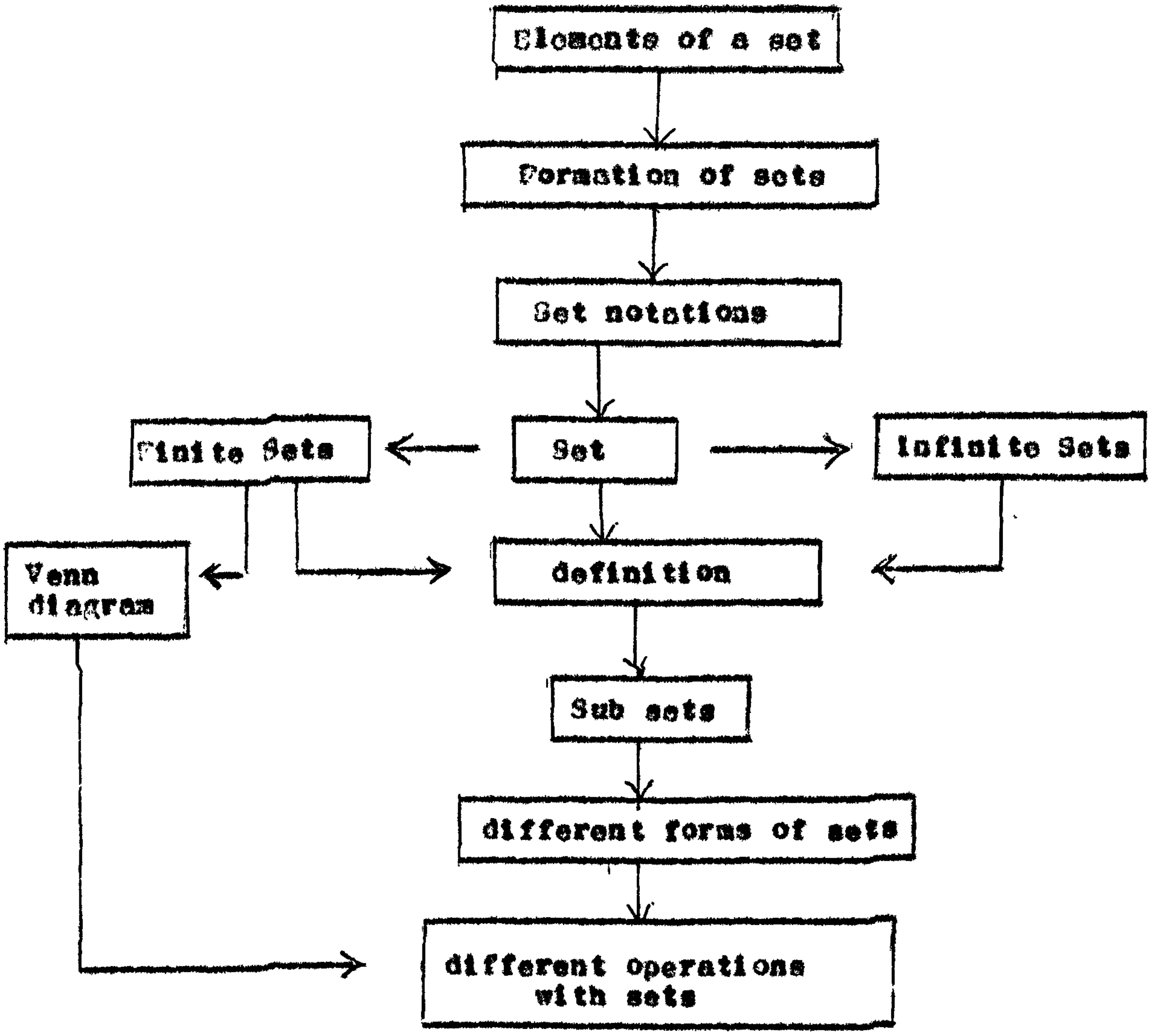
The content selected for the programmed text was a chapter on "Set Theory" prescribed for secondary classes by the Rajasthan Board of Secondary Education. This is a part of modern algebra and has recently been introduced in the syllabus. For programming the contents of the course were arranged in a logical order in the following manner.

1. The sets: meaning and definition
2. The set notations
3. Rule and tabular form of sets
4. Sub sets, null set, complementary and difference sets
5. Union and intersection of sets
6. Venn diagrams

Appropriate sequence for the presentation of the content was decided on the basis of the following flow chart prepared

Flow Chart - Showing interdependency of different concepts of Set Theory.

Unit: <u>Set Theory</u>



to discover the interdependence of different concepts to be covered and the demands they made on the sequencing of the content material.

Target population and entering behaviour:

The programmed text was specifically prepared for using it as self instructional material in the course on set theory prescribed for secondary school classes of Rajasthan. As this topic is taught ab initio hence no specific behaviours related to the knowledge of sets etc. is required as entering behaviour. But even then this topic in mathematics can not be taught without some pre-requisites. Therefore, the following pre-requisites or entering behaviours were required for the programmed text.

1. Students should be able to identify objects with similar properties.
2. They should be able to calculate the value of a^n when value of 'a' and 'n' is given.
3. They should have the knowledge of natural numbers and whole numbers.
4. They should be able to operate four fundamentals correctly.
5. They should be able to locate numbers on number-line.
6. They should be able to draw a rectangle and circle
7. They should be able to discriminate between different and dis-similar objects.

8. They should be able to discriminate between finite and infinite series of numbers.

9. They should have the ability to group objects having some common characteristics.

10. They should have computation skills, viz., finding squares, square roots etc.

Terminal Behaviour:

As every instructional process connotes a specificity of purpose, the first step in its planning would be the classification and definition of terminal behaviour which is to be accepted as minimum evidence that the instruction has been successfully completed. Further, the description of the "terminal behaviour", that specifies the instructional objectives, must be in measurable terms and supplemented by a description of the situations to which this behaviour is judged to be an appropriate response. This is to be done in order to make the description of terminal behaviours more objective and explicit.

Considering the proficiency that a student should acquire through the programmed text on set theory the following terminal behaviours are considered essential as criteria of learning.

1. The student after the completion of the programme should be able to define a Set as "a group of well defined objects".

2. The student should be able to form a set or sets from given objects.

3. The student should be able to discriminate amongst different set notations, viz., $\in$, $\subset$, ϕ, $\cap$ and $\cup$

4. The student should be able to convert general form of a set into tabular form and vice versa.

5. When a set is given, the student should be able to form different subsets with its members.

6. The student should be able to calculate the number of subsets which can be formed out of a given set.

7. The student should be able to define a null set as a set without elements.

8. From two given sets, the student should be able to form union-set.

9. When two sets are given, the student should be able to find out the intersection of the sets.

10. He should be able to multiply two sets in order to form a new set.

11. He should be able to draw and interpret Venn diagram of a set.

12. When two sets are given, the student should be able to find out intersection and union of these sets with the help of Venn diagram.

<u>Format and Style:</u>

Several types of format can be adopted in presenting frames and correct responses in a programmed lesson.

Frames:

A frame has been defined by Faber et al. (1963) as a small segment of subject matter which calls forth a specific response from the student. Usually there are four parts of a frame: the stimulus, the response, the enrichment material, and the prompt.

These components can be clearly made out in the following example of a typical frame (No.15) in the programmed text used in the present study.

Fig. 3.1 Example of a frame

15	In S = $\{2,4,6,8,10\}$ numbers of elements is 5 Here element "2 is the member of S" It can be written in notation form as $2 \in S$ Write "4 is the member of S" in notation form
$4 \in S$	

Here the stimulus is given in the form of a problem: Write "4 is the member of S" in notation form; the response which is given slightly towards the left, outside the frame is $4 \in S$; the beginning part of the frame is the enrichment material; and "2 is the member of S" is a prompt.

The function of the stimulus in a frame is to motivate the learner to interact with the learning material. It causes the learner to think a probable solution of the problem which has been presented to him in the learning situation. In case of Skinnerian type of linear programming where filling in the blank is the main task, it is the context in which the blank space is placed which acts as the stimulus may be a question or a problem.

In programming the present material no uniform kind of stimulus was provided. As mentioned elsewhere also, stimuli were varied according to the requirements of the material used in the various frames. While developing programmed instruction, proper care has been taken by the programmer that the learner attends the key words or concepts in the frame so that he may interact with it and arrive at the correct response.

The enrichment material in a frame is important in the sense that it helps the learner to recall the previously learnt material and thus provides a congenial context for the stimulus. This part is, however, not considered an essential part of the frame and is given only when learning situation is complex and some context for it is to be provided. It may help the learner in focussing his attention on the probable lines on which the correct response may fall. In the programme used for the present study, enrichment material has been used only in frames which have aimed at developing some concepts or clarifying some rules and principles.

Prompts are cues provided in the programmed frames to guide the student to the correct response. They are supplementary stimuli in that they are added to a frame to make it easier for the learner to reach the response but not sufficient in themselves to produce the response. As such, prompts have two basic purposes. They guide the student to the correct response without overcontrolling his behaviour, and they prevent the student for making unnecessary errors. This indicates that while writing programmed text, prompts should be used when a new concept is being introduced in the frame. But over prompting as well as under prompting should be avoided. The former leads to spoon feeding whereas the latter is meaningless as it does not help the learner in giving the correct response.

In the present programmed text different types of prompts have been used depending upon their suitability in the specific learning situations. The following are the examples of the types of prompts used in the present study.

Fig. 3.2. Example of partial response prompt

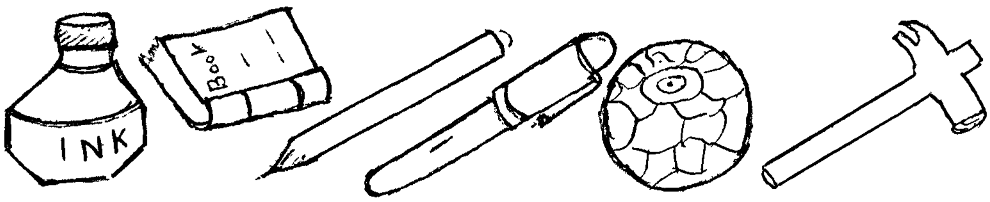
	A set of names of Presidents of India is as follows Rajendra Prasad, ------, ------, ------, ------
Rajendra Prasad, Radha Krishnan, Zakir Husain, V.V. Gri, Ahmad	

Here a part of the desired response i.e. Rajendra Prasad is given. This is expected to stimulate the learner to write names of the remaining Presidents of India.

Fig. 3.3. Example of frame structure prompts

	The notation for "Is not a sub set of "is $\not\subset$ "A is not a sub set of S" can be written as A - - - S
A $\not\subset$ S	

Fig. 3.4. Example of Pictures as a prompt



	From the above pictures form a set of things used in reading and writing
Ink pot, Book, Pencil, Pen	

Fig. 3.5. Example of "A rule as a prompt

	Number of sub sets = 2^n , where n is the number of elements in a set. $A = \{a, b, c\}$, here n = 3 Number of sub sets = $2^n = 2^3 = 8$ Find out number of sub sets in $S = \{p,q,r,s\}$
2^4 or 16	

The efficiency of the thematic prompts, as shown in the last two examples, depends upon the student's previous association of a word, phrase or a theme. Such prompts inform the students about the correct response without revealing the form of the response.

Response in a programmed lesson, according to Skinner (1958), should be in the form of observable behaviour on the part of the learner, which can be subjected to objective measurement. The response when given by the learner may also be taken as an evidence of learning a particular behaviour. Fry (1963) points out that it is the "overt response which indicates that the student is responding to the programmed material, it is the overt response which must be taken as an indication of a correct form of behaviour and therefore encouraged by all available means".

Hence it is essential to make the responses expected of the learner *meaningful, concrete and concise*. Programmed instruction demands from a learner to produce an overt response to each stimulus offered by the programme, for example, by writing out his response or by pushing a button to indicate his choice. Fry (1963) emphasized the importance of response by pointing out that one of the principal differences between programmed instruction and a traditional text book is that the former calls for a response from the student to each unit of information that is presented while the latter does not incorporate it as a necessary part of a lesson.

The function of the correct response included in a frame is that the learner can compare his own response with it. If his response tallies with the correct one it gives him a sense of satisfaction which is reinforcing.

When Skinner (1954) applied his experiences with animal training to human learning, he defined response confirmation as reinforcement in the sense that it increases the probability that the desired behaviour will appear at the appropriate time. In other words, to tell the student that his answer is correct is a form of reinforcement. Even earlier than Skinner, Perin in 1943 gave expression to this understanding that the knowledge of a response being correct was a reinforcer for human beings.

We find that majority of the studies in the area of learning support the idea that immediate knowledge of results contributes to learning. Angell (1949) using Pressey type questions, and Meyer (1960) using linear programme, found significantly more learning by a group that received immediate knowledge of results than by a group that waited for the next meeting of the class to find out the results. Michael and Maccoby (1953) found that immediate knowledge of results contributed significantly to learning from an instructional film with questions inserted.

In cybernatic term immediate confirmation of results is called feedback. This feed-back not only reinforces the response but also motivates the learner to study the next frame and thus S-R chain continues.

As mentioned earlier, the responses provided in the present programme deviate from the traditional type of responses in that, instead of being comprised of only one or two words, they vary from a word to a sentence. The following are the representative examples.

Fig. 3.6. Example of one word response

	If $A = \{a, b\}$ then number of sub sets can be written as ϕ, $\{a\}$, $\{b\}$, $\{a,b\}$ The total number of sub sets is ----
Four	

Fig. 3.7. Example of one line response

	In A = $\{a, b, c, d\}$ and B = $\{x, y, z\}$ find out if there is any element common to these sets
There is no element common to these sets	

Attempts has been made to maintain objectivity, in both short and long types of responses, in the sense that there can be no response to the stimulus other than the one given in the frame. Usually response of one frame has been related to the stimulus for the next frame. This process is continued till one concept has been taught to the learner. Example may be seen in the programmed text from frame No.1 to 14 - development of concept of set - frame No.46 to 63 - development of concept of sub sets (Cf. "Programmed Instruction on Set Theory" given in supplement).

In programming the material for the present study frames have been presented in between horizontal lines, and the correct response is given immediately after the frame. This format was selected for the present investigation in preference to other formats like writing correct answer on some other page or writing frames on different pages because it was judged to be simpler to understand and to interact with.

Students were provided with a card for covering the correct answer of the question given in the frame. A separate response sheet was given to them to write their answers. The students were asked to read each frame carefully to write their own answers in the response sheet and compare this answer with the correct one given in the programmed text.

Frame size:

The principle of small steps, a major principle in linear programme, has been strictly followed in the present text. Although frames of different size have been included, the difference is only in respect of the space occupied in the programmed text. In fact each frame strictly presents only one single point of learning which can be easily understood by the population under study. Thus a frames, though sometimes large, represents an optimal as well as learnable segment of knowledge to be acquired. This aspect can be clearly observed in the following example of three successive frames in the programmed text, which are apparently of different sizes but each of which conveys only one point of learning.

Fig. 3.8. Examples of frames with varying sizes

In above sets elements can be arranged in any order.

{Inkpot, Book, Pencil, Pen} and {Book, Pencil, Pen, Inkpot} are similar sets. Hence arrangement of elements does not affect value of a set.

Form a set from element A and N

Generally, we use small letters like a, n in forming sets {a, n}

Form a set of prime number between 14 and 30

Form set of names of months beginning with letter J.

Frame Structure:

Another essential component of a frame

is the frame structure, which connotes specific types of problems included in different frames. Programmes written in the traditional linear form as the one by Holland and Skinner (1961) adopted completion type sentences as the uniform type of frame structure. The assumption behind a uniform use of this frame structure is that students learn better if they have to construct their own responses instead of simply choosing the correct one from a given set of responses.

In preparing the present programmed text, however, no uniform frame structure was followed. The frame structures among others, include completion type, alternative, response (yes - no) type, matching type and problem solving type. The type of frame structure was varied in order to avoid boredom from a monotonous type of task. Besides, the frame structure was also varied in accordance with the requirements of different situations and different types of problems involved in the topic to be taught. One basic characteristic of all these frame structures was that the learner was required to construct his own response except in the case of matching type and alternative response type of frames. Examples of some frame structures follow.

Fig. 3.9. Example of yes or No - alternative response type of frame

	If C = $\{d, e, f, g\}$ then find out which of the following statements are correct. 1. $d \in C$ 2. $e \notin C$ 3. $a \in C$ 4. $a \notin C$ 5. $g \in C$
1. Correct 2. Incorrect 3. Incorrect 4. Correct 5. Correct	

Fig. 3.9. Example of Matching Type Responses

	N,W,I,P represents usual universal set notations. In column A statements are given and B represents answers. Match every statement with correct answer. A B 1. Set of Natural numbers (a) W 2. 0,1,2,3,4 - - - - - - (b) P 3. Set of Prime numbers (c) I 4. .... -3, -2, -1, 0,1,3,3 .. (d) N
1. N 2. W 3. P 4. I	

Fig. 3.10. Example of completion type response

	A set of names of president of India is as follows {Rajendra Prasad, -----, -----, -----, -----}
{Rajendra Prasad, Zakir Husain, V.V. Giri, Radhakrishnan, Ahmad}	

Fig. 3.11. Example of long response type

	Write down $\{2^3, 4^3, 6^3 \text{ ----}\}$ in the tabular form when n^{th} term is 2n
x:x $x = (2n^3)$	

Long answer type frames have been included in such situations where the students need greater freedom to express their responses which are required to conform to the correct answer only in the theme and not in the construction of the sentence.

Although, frame structure has not been kept uniform, the response mode has been uniformly overt in nature. For each frame, whether the problem in it is completion type or matching type or any other type, the student has to indicate in writing his answer on the response sheet. Then he compares his answer with the correct one provided in the programmed material. He proceeds to the next frame only when his answer is correct; but if his answer is incorrect he is required to read the previous frame again, understand the point and then proceed further.

Frame Style:

The present programmed text has been written in linear style, although it is not a linear programme of the traditional Skinnerian type such as the one written by Holland and Skinner (1961). Skinnerian programming followed a stereotyped fill up the blank style, where every statement in a frame had one or two words missing. The student was asked to fill up these blank spaces. Any how, the style of the present programming is basically linear as all the students have to proceed through the same sequence of frames. The style of programming adopted in writing the present programmed text bears certain similarities with the one followed by Phapham and Baker (1970), who also deviated from the strictly Skinnerian style.

Frame Sequence:

It is a usual practice generally followed by programme writers to arrange frames in a logical order. Some other approaches to frame sequencing have also been evolved, but the major approach to frame sequencing adopted in linear programming are "Ruleg" and "Egrule". The "Ruleg" system is based on the understanding that it is advantageous to present the rule first and the examples related to the rule afterwards. In "Egrule" system, on the other hand, it is preferred to present a series of examples first and get the student to derive the rule himself.

The choice of "Egrule" or "Ruleg" for a particular programme system depends upon the circumstances of the learning process involved. If a difficult concept is being taught, there is little possibility that the student would understand it if it is stated in abstract form initially, and therefore, Egrule system is preferable to Ruleg system. If, however, the general or abstract presentation is easily understandable it would be justifiable to give the rule first and then provide examples and counter examples, that is, to employ Ruleg system.

In the present programmed text, generally, the Egrule system has been adopted. This rule has been chosen in preference to Ruleg because the target population was completely unfamiliar with the concept of "Set", and it is assumed that in such situations the Egrule system would work better than the Ruleg system. However, no rigidity has been maintained in the adoption of the particular frame sequencing system. In certain instances, Ruleg system has also been adopted in view of its suitability for the particular unit, but such cases are few in number.

Writing the Frames

The frames for the programmed material on "Set Theory" were written following the specifications described in the preceeding sections regarding the style, nature of the frame, sequence of the subject matter etc. Frames were written on index cards, with the correct responses on the back of the card. These frames were tried on five students one at a time.

The students were required to read the frame, give a response and then turn the card for confirmation or correction of their response. The investigator worked closely with each student at this stage of programme development trying to locate the steps where the respondent committed mistakes. Frames where errors were committed frequently were then revised until the students learnt from it without making mistakes.

The original draft was then edited by an eminent educationist who had a wide experience in programme development.

The editing was also done by the investigator in the light of a checklist of do's and dont's developed by Markle (1964) which is as follows.

1. Frames should be written clearly in good language (in the present use Hindi).
2. What is said should be correct.
3. The response required of the student should be relevant to the purpose of the frame.
4. If multiple choice questions are used, the alternatives should be feasible answers.
5. Frame should contain sufficient context to make clear what is being presented and what is wanted.
6. In frames a large number of points to all of which student cannot respond at a time should not be included.
7. Irrelevant material should be eliminated from the frames.
8. In concept teaching, representative sample of illustrations and a few negative example as well should be provided.
9. As far as possible ample use of thematic prompts and sparing use of formal prompt should be made.
10. The size of the steps should be reasonably small.

In the light of suggestions given by the editor of the programme, several modifications like changing the language of the frame, altering examples and using prompts where the student failed to respond correctly were made. Along with the programme the criterion test was also scrutinised by experts for its content validity in view of the terminal behaviour determined earlier.

Try out and revision:

After editing and making subsequent changes in the programme, it was carefully duplicated and then tried out on thirty students. This time it was assumed that the programme material had taken the full instructional responsibility and the teacher did not interfere in the learning process. The response sheet bearing numbered blanks were given to every student who recorded their responses in it. After they had completed the programme a test of terminal behaviour was also given to them. The errors committed by the students were noted framewise, and a list of common errors was drawn up. This helped in locating the part of the programme which was ineffective. The conventional standard of errors rate i.e. 10 percent of students making error in responding a frame, was taken as a criterion for revising the frame. Similarly, students performance on the criterion test was also analysed and weaker frames were identified on the basis of this analysis.

Based on the analysis of errors on the programme frames and on criterion test items, and also considering the difficulties reported by the students, the programme frames were revised. Revision was effected regarding the language, the frame sequence, structure of certain frames and other related aspects. Wherever found necessary, frames were split into smaller ones and also additional frames were introduced.

The programmed text after revision was again cyclostyled and made ready for being used for the main experiment.

CHAPTER - IV

DESIGN AND METHOD

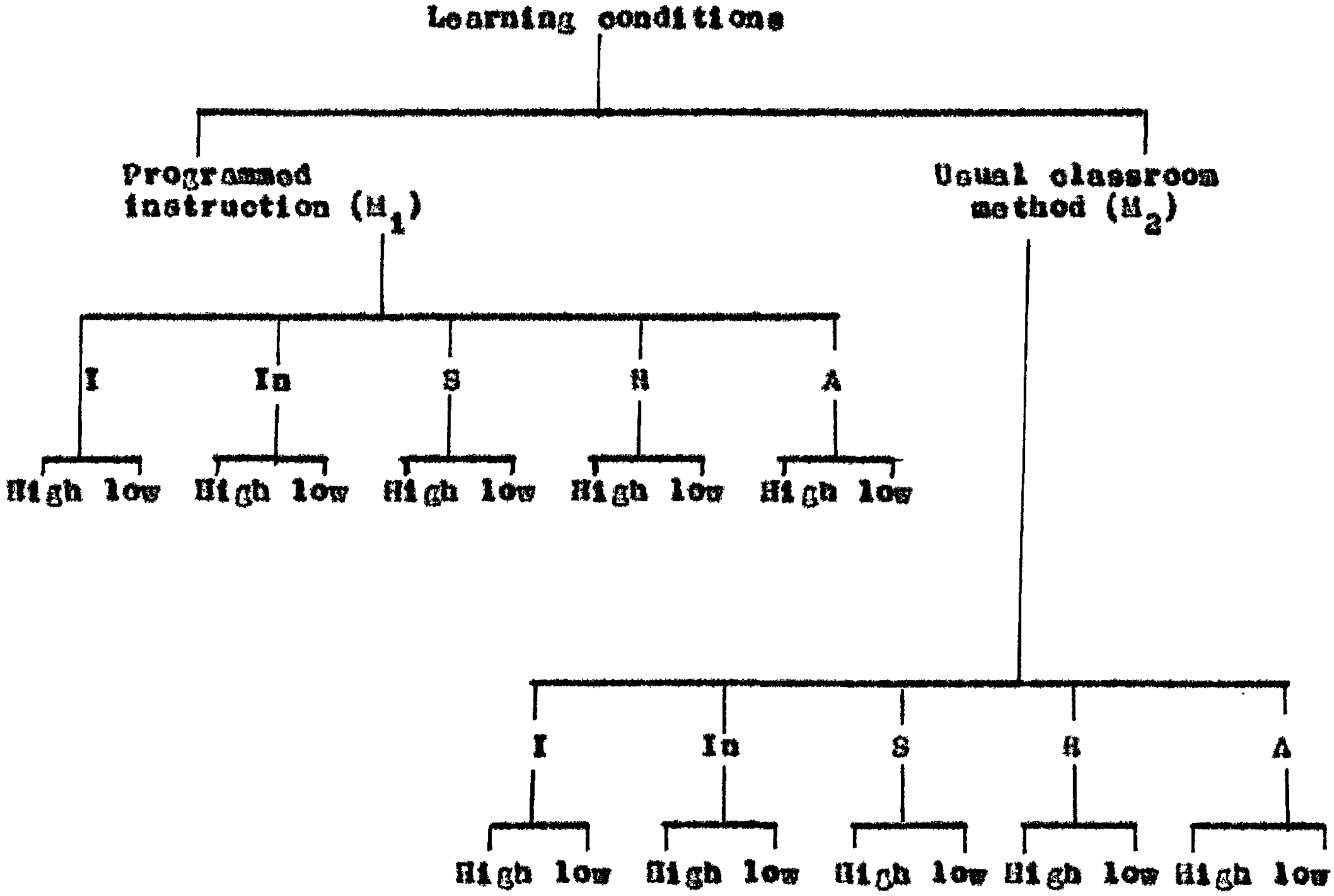
Design:

The design of a study is bound up with its purpose and nature of variables to be used. As discussed earlier the purpose of the present study was to compare the learning outcomes of students in terms of post-achievement scores in set theory when they had been taught either by programmed instruction (M_1) or by a teacher through the conventional methods of teaching (M_2). Further, this study aimed at finding out how the method of programmed instruction affected the levels of achievement of individuals who differed in intelligence, (I), introversion (In), rigidity-flexibility (R), study habits (S) and previous achievement scores (A). These five variables - two relating to personality and three providing significant antecedent and organismic conditions - were taken as independent variables. Further the group taught by programmed instruction (M_1) is termed as "experimental group" whereas the group which received instruction by the teacher in conventional manner (M_2) is termed as "control group". The two dependent variables of the study are immediate and delayed post achievement scores.

The design of the experiment has been represented in the diagram.

Diagram No. 1.

Showing scheme of classification



The high and low groups in the different dimensions of individual differences have been obtained by classifying the subjects on the basis of P_{40} and P_{60} as the cutting points. These cutting points are given in Table No. 1.

Table No. 1.

Cutting points for formation of high and low groups

S.N.	Variables	P_{60}	P_{40}
1.	Intelligence (I)	48	41
2.	Introversion-Extraversion (In)	28	22
3.	Previous Achievement (A)	23	20
4.	Study Habits (S)	53	40
5.	Rigidity-Flexibility (R)	15	11

On the basis of above mentioned cutting points students were placed in "High" and "Low" groups in relation to each variable, except in the case of introversion-extraversion where,as the inventory is scored in favour of extraversion, lower percentile denotes "High" group and higher percentile "Low" group on introversion. Ten sub groups were, thus, formed under programmed instruction and ten under the usual classroom method.

For analysing the results factorial design has been used. The introduction of factorial design for this purpose may be justified on the ground that in this type of design each factor is investigated in combination with all the other factors. To quote Lewis (1968) "The factorial experiment not only provides all the information possible from the separate, *one-factor-experiments (and, moreover, does so more efficiently)*; it also provides information about the interaction of the factors". This is an important advantage, in that knowing only the effect of a factor with all the others held constant does not provide any indication whether this effect would remain the same at all levels of the other factors.

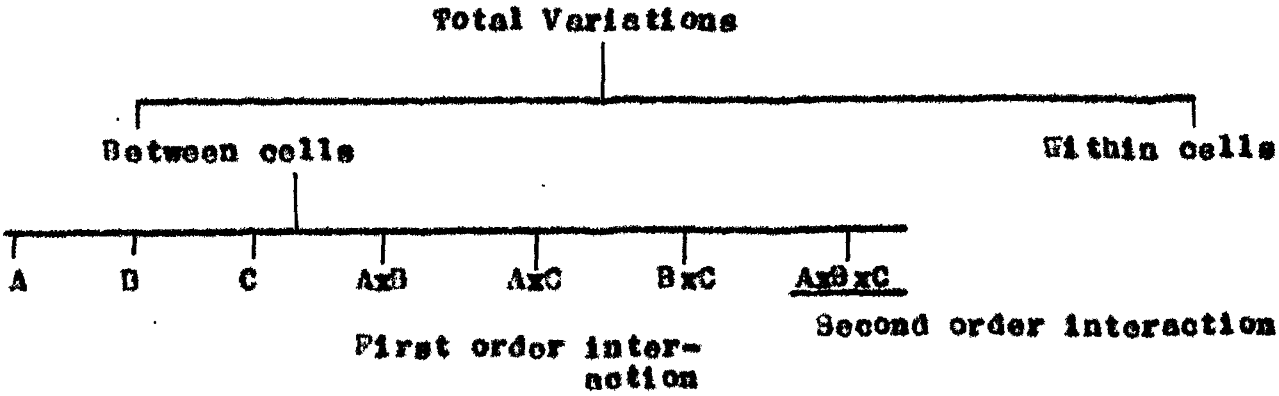
In the present study two levels of each of the six independent variables, viz., intelligence, study habits, methods of instruction, previous achievement in mathematics, introversion and rigidity are to be analysed in relation to post achievement scores. As such 2 x 2 x 2 x 2 x 2 x 2 design was warranted. However, in doing so as many as 64 cells would have to be formed for different combinations. It would have required the analysis of six main effects and an unwieldy number of different orders of interactions. The actual computations would have become increasingly difficult. Besides, each higher order interaction, if statistically significant, would have limited the scope of any conclusion drawn from the main effects and the lower order interactions involving the same factors. To quote Lewis (1968) again in this connection "complete factorial design with four or more factors, are, in fact seldom employed in educational research. This is because with a large number of factors, and also with a large number of levels for each factor, the experiment becomes unwieldy. Even if we test five factors each with two levels we would have 2^5 or thirtytwo cross classification in all*.

It is because of the above considerations that instead of a 2 x 2 x 2 x 2 x 2 x 2, i.e. six factor design a 2 x 2 x 2 i.e. three factor design has been used in the present analysis. The reason for selecting this design was that with a smaller number of variables it was easier to form cell (block) for the different variables and their classification levels having sufficient and statistically meaningful number of cases falling in each cell (block).

In order to explain the break up of variations in three factor experiment, the three independent variables can be designated by A, B and C. For finding out differences between the levels of each of these factors and the differences arising out of the interactions of these factors, the investigator had to find out the main effect, the first order interactions i.e. A x B, A x C, B x C and the second order interaction i.e. A x B x C. A break-up of variations in a three factor design is represented diagrammatically in Diagram No. 2.

Diagram No. 2

Showing break-up of variation in three factor design



These steps were to be repeated for all the possible combinations of six independent variables (including method of instruction).

Out of the six independent variables if three were taken at a time at two levels of classification, this would have resulted in 20 combinations or sets of variables to be analysed by 2 x 2 x 2 factorial design. But since the study was concerned with the effect of methods in relation to the remaining independent variables, possible combinations without methods were excluded. Thus only, ten combinations were retained.

In each analysis of variance the two variables - V_1 and V_2 were varied at two levels high and low, and there were further combinations with two methods, viz., programmed instruction (M_1) and the usual classroom method (M_2). This resulted in the formation of eight cells; high V_1 high V_2 M_1, high V_1 high V_2 M_2, high V_1 low V_2 M_1, high V_1 low V_2 M_2, Low V_1 high V_2 M_1, Low V_1 high V_2 M_2, Low V_1 low V_2 M_1 and Low V_1 low V_2 M_2.

For developing the tables "Achievement Scores" of students- falling under each of the two categories (High and Low) of the independent variables were picked out and placed in the appropriate cells. In this way almost the whole data was utilised for forming the 80 different cells (8 cells x 10 analyses) for achievement scores and the same number of cells for retention scores.

Tools:

Tools used for measuring individual differences with respect to different personal variables are described below.

1. Intelligence Test:

For measuring intelligence of students a good number of tests, viz., "The Allahabad Intelligence Test" (1948), "Bureau of psychology Intelligence Test" (1955), "CIE Group Test of Intelligence" (1961), Prayag Mehta's "Test of Intelligence" (1962), Jalota's "General Mental Ability Test (1964) and Mehrotra's "Mixed Type Group Intelligence Test of Intelligence" (1975) are available for use with the high school group of subjects.

Out of these, the revised edition of Jalota's General Mental Ability Test (1964) was selected for use in the present study due to many reasons, the most important of those being the test is the recent one and the vocabulary used in it is simple and, thus, most suitable for use with a group of high school students in Rajasthan. One point in favour of the test was that it has been recommended by the Board of Secondary Education, Rajasthan, for use in schools for the purposes of "internal assessment". Another reason for the choice of the test was its easy availability and the fact that teachers in the schools where the study was carried out were familiar with the procedure of its use.

The test comprise of 100 items which are divided into seven sections. These sections are as follows:

1. Vocabulary: Synonysms and antonysms
2. Classification
3. Mathematical Series: arithmetic; geometrical progression
4. Identification
5. Resemblance
6. Ratio and proportion
7. Solution of problems

The test also contains 14 practice items. These enable the testees to get familiar with the trends of items included in the test and the tester to be sure that the instructions given by him have been understood and followed.

Instructions for the testers are printed at the beginning of the test booklet. First the testee makes himself familiar with the test by solving practice items. Then he is asked to solve 100 items within 20 minutes duration. For recording answers, separate answersheets are given. In a case a testee completes the items before the time is over, a provision for revising the test has also been made.

Rigidity-Flexibility Scale:

The Gough-Sanford Rigidity Scale (1952) was used in the study for measuring rigidity. The scale consists of 22 items. The scale is widely used in psychological studies as a measure of rigidity and is included in the California, Psychological Inventory where it is labelled Fx (flexibility).

Rigidity as conceived by the authors of the scale refers to the tendency to perseverate or to resist any change in the mental sets, habits or beliefs, that is, in the modes of thinking and behaving, even when they are no longer appropriate. An individual scoring high on the rigidity scale may find it difficult to adopt himself in the new situation because it may require modification in modes of conduct, habits and attitudes.

The above scale was translated into simple Hindi by Ali (1973) for use in his Ph.D. work. The translator claimed to have exercised utmost care to ensure that the translated version reflected truly the sense contained in the original items of the scale. The translation is also reported to have been examined by the experts in psychology and Hindi. The translated version of the scale was found by the present investigator to be simple and easy to understand. It was considered highly suitable for the population of the present study.

While taking the test the subject is required to record his response by placing a tick mark in case of agreement and a cross in case of disagreement in brackets provided against each statement. The procedure of attempting the test is explained in the beginning of the test. Also there is no time limit set for completing the scale.

The split half reliability of the translated version of the scale (G.S.R. Scale) is reported by the translator to be .74. As for validity, the scale correlated significantly with California F Scale (r = .58, N=50) with which it is understood to be conceptually related.

The scale is scored in the direction of rigidity and out of the 22 items agreement with 18 items and disagreement with the rest 4 items shows perfect rigidity as measured by the scale.

Introversion-Extraversion Scale:

Introversion scale used in the present study is based on the Maudsley Personality Inventory (M.P.I.) which measures two orthogonal personality dimensions, viz., Neuroticism and Introversion-Extraversion. The M.P.I. is an improvement on Maudsley Medical Questionnaire (Eysenck, 1959).

The Maudsley Medical Questionnaire (M.M.Q.) was constructed to measure personality trait of neuroticism and it succeeded in differentiating between normal and neurotic soldiers. Since M.M.Q. was not found to be a suitable measure of personality trait of neuroticism among normal individuals, construction of a new scale was considered to be desirable by Eysenck. He also availed the opportunity to devise a new sub scale for measuring dimension of introversion-extraversion.

Since factor analytical studies carried out by Lovel and North had suggested that Guilford's C Scale (Cycloid disposition) was a good index of neuroticism and his R Scale (Restrain vs Rhathyma) was a good measure of extroversion, Eysenck utilised 261 items drawn from Guilford's Scale as well as from the M.M.Q. for the construction of M.P.I. Items having Chi square value of 10 or above were selected by him for measuring the dimensions of neuroticism and introversion-extraversion.

The Hindi version of the M.P.I. was prepared by Jalota and Kapoor (1965). There are 48 items in the Hindi version of the scale, twenty four for each of the two dimensions. Subjects are to indicate their response by putting a tick mark in one of the three categories of response "Yes" "No" and "?".

The items covering the dimensions of introversion-extraversion are scored in the direction of extraversion.

Out of 24 items of the scale 16 items when responded to by a "Yes" and 8 items when responded to by a "No" are scored "2" each, items responded to by "?" are scored 1 irrespective of the direction of the item. Thus high score on the introversion-extraversion scale indicates high degree of extraversion.

Study Habit Inventory:

Study Habit Inventory used in the present study was developed by Rastogi (1966). This is based on two study habit inventories, viz., Brown Holtzman Survey of Study Habits and Attitudes (1953) and Gilbert C Wrenn' Study Habit Inventory (1941). Six areas related to study habits covered by it are as follows:

1. Ability
2. Study habit
3. Interest and Attitudes
4. Techniques of study
5. Nature and temperament
6. External factors

Items of the Inventory have been framed on the basis of description of selected activities. Out of 115 items included in the first draft 49 were rejected after item analysis as their discriminating indices were poor (r value below .4). In all 66 items were retained in the final form of the inventory. These include ten items for ability, ten for study habits, ten for interest and attitudes, fourteen for technique of study, twelve for nature and temperament, and ten items for external factors.

Instructions are printed clearly on the cover page of the test. The subject is required first to read each item, which is in the form of a statement and then to select one out of the three given response, viz., "Yes" "?" and "No"; and encircle it. A separate answersheet is provided to the subject for recording his response. As is obvious "Yes" indicates a total agreement, "No" a total disagreement with the statement and "?" represents a state of indecision. Only those responses which indicate good study habits are scored "one" and the total of these scores represents study habit of the testee.

There is no time limit for completing the items of the test, hence sufficient time was given to each testee to enable them to respond all the items. The average time required for this test was one hour.

The reliability of the study habit inventory (final form) determined by split half method has been reported to be .79. Its validity has been checked against examination marks probably with the assumptions that students with good study habits will achieve better. The correlations of the total examination marks with each one of the six areas was found to be significant at .01 level of confidence. The correlation value ranged between .00 and .98.

Previous Achievement Test in Mathematics:

In order to measure the level of achievement in the relevant area of mathematics, prior to the experimental teaching a test was developed by the author. On a standardisation sample of class IX students taken from schools similar in all respects to those where the experiment was to be made. The test was based on the topics which were expected to have been taught to all the subjects of the study before the introduction of the Set theory. The construction of such a test was necessary because no standardised test in mathematics was available which could measure this relevant area of knowledge. The area covered in the test were as follows:

1. Simple factors
2. Linear equations
3. Symbols
4. Natural Numbers
5. Series: A.P. and G.P.
6. Theory of indices
7. Circles

The first draft of the test contained 85 items. The items were administered to a population of 79 students who were studying in IX class. After rejecting items having poor discriminating index only 50 items were retained. All items were of multiple choice type, with four alternative choices each. Students were asked to select one out of the four alternatives and write the corresponding letter a, b, c or d in the brackets given against each item. The final form of the test was cyclostyled on fullscape sheets. No instruction were printed on the test mainly because the students of all the schools taken for the present study were familiar with objective-tests in routine testing of achievement in the schools. Brief oral instructions, particularly, to impress upon the subjects that the test had nothing to do with their examinations were considered sufficient.

In constructing the previous achievement test the present investigator allowed himself one deviation from usual testing procedure in that no time limit was initially fixed for this test. It was argued that the purpose of this test was to gauge all that the students knew before being taught the set theory, as such the rate of responding was considered less important than the content of knowledge measured by the test. Hence a fairly liberal allowance of time was given. It was, however, found that on the average, one hour was sufficient for attempting the test.

The reliability of the test, after item analysis, calculated by split half method was found to be .83 (N=79). In order to find out validity of the test coefficient of correlation between scores of students on pre-test and marks obtained by them in their final examination of class IX was calculated. The value of r was found to be .70.

Post Achievement Test:

The post achievement test was also developed by the author as no standardised achievement test was available which could reliably measure attainment of students in Set Theory. An unstandardised teacher made test could have served the purpose, but to ensure objectivity and reliability, it was decided to standardise this test as well on a sample similar to that of the study.

The post achievement test, in its first draft, included 85 items. The test was administered on a sample of 58 students and after item analysis 50 items were retained. The area covered by this test are mentioned below.

1. Concept of set
2. Set notations
3. Rule and tabular form of sets
4. Null sets
5. Sub set

6. Complementary and difference sets
7. Union and intersection of sets
8. Venn diagram

All items of the test were of multiple choice type, with four alternative choices provided for each item. The student was asked to select the best alternative and mark it on the test paper. Each correct answer carried a score of one. Thus the maximum score which one could be secured in the test was 50. Maximum time allowed was one hour.

The reliability of the test calculated by split half method was found to be .95. For finding out validity of the test coefficient of correlation between the scores on the test and the marks obtained by the subjects in the final examination of class IX was calculated. The obtained coefficient was .73.

Delayed Test of Achievement:

This test was in fact a parallel form of post achievement test. This test was intended to be as close in content and format to the first test as possible. The serial number and the wordings of the items were, however, changed in such a way that it appeared to be a different test.

The Sample

As mentioned earlier the geographical area selected for the present study was Jaipur City. This particular city was selected because of several reasons. The foremost of these being that the investigator was posted in a school in that city. Hence schools required for the study were easily approachable. No difficulty was encountered in obtaining permission for administering tests etc. and carrying out the experiment. The population of the study consisted of 378 students studying in IX standard in eight different schools of Jaipur. Out of these 176 were boys and 202 were girls. These boys and girls came from varying socio-economic backgrounds, were of different intelligence levels and of different levels of academic success. Individual differences in personality and study habits in this large population were also expected to be wide. Thus, although no elaborate methods of systematic sampling were employed, it was believed that the large number itself would safeguard against biases in sampling.

Procedures

The intelligence test, introversion-extraversion scale, study habit inventory, rigidity-flexibility scale and the test for measuring previous achievement in mathematics were administered on the subjects in their classes before they were divided into groups for programmed instruction and classroom teaching.

As it was impossible to administer all the five tests in one day, they were administered on three different days. For doing so a plan of action was developed with the help of subject teachers (experts in evaluation and measurement) and administrators of the schools.

After administration of every test five to ten minutes interval was allowed to the students so that they could feel rested relaxed before attempting the next test. Amongst the five tests, the tests for study habits and previous achievement were the longest, each requiring one hour for it's administration. Hence those two tests were given to the testees on different days.

Care was taken that the gap between measurement of the independent variables and teaching of set theory should be of 10 days at the most. For previous achievement test this period ranged between 1 to 4 days. The reason for administering the test in the last was to have latest score of achievement prior to the teaching of set theory.

The present study being a comparative study of achievement by two methods, groups to be taught with the respective methods were put through as similar testing conditions as possible. As testing conditions also play an important role in determining the scores, proper and congenial conditions were provided for testees. Wherever necessary clear oral instructions were given to the testees in simple Hindi. Examples or practice items were solved on the black board and doubts or difficulties felt by students were removed by giving suitable explanations. Efforts were made to keep oral instructions and explanations uniform for all the groups.

In order to draw legitimate inferences about population from the sample it is necessary to ascertain that the sample really represents the population. If the sample is drawn from the population in a biased manner so that it is not representative of the population, there is no justification for generalising from the results from sample to population.

The school selected for the present investigation are Government schools where there is no restriction on admissions. Consequently students from different strata of society secure admissions. In this way the sample selected is not biased. Also, these schools are scattered over a radius of 8 Km. This gives chance to every type of students to be included in the present sample.

As the main purpose of the study was to find out the influence of two methods of teaching, singly and in combination with other variables, on achievement in mathematics the next step was to assign subjects to two comparable groups to be taught respectively by the two methods. However, assignment of the subjects to the groups was not feasible either on the basis of random allocation or on the basis of matching with respect to relevant variables. Such an attempt would have disturbed the natural setting of the school classes and would have made teaching, at least by classroom method, difficult. The subjects were, therefore, assigned to the two groups sectionwise. If there were four science sections in a school to whom set theory was to be taught, two were assigned to the programmed instruction group, and two for classroom teaching group, if there were two sections, one was assigned to programmed instruction and other to classroom teaching. If there was only one science section in a school, the school was paired with another nearby otherwise similar school and one section of the pair was taught by conventional method while the other by programmed instruction. The detailed scheme of allotment of sections to two groups is presented in Table No. 2.

Table No. 2

Allotment of sections to experimental and control groups

S. No.	Name of the school	No. of sections in IX class	No. of sections allotted to Exp. group	No. of students in Exp. group	No. of sections allotted to control group	No. of students in control group
1.	Raja Ram Deo Poddar Higher Secondary School, Jaipur.	4	2	60	2	54
2.	Higher Secondary School, Adarsh Nagar, Jaipur.	1	1	29	-	-
3.	Maheshwari Higher Secondary School, Adarsh Nagar, Jaipur.	1	-	-	1	33
4.	Maharani Girls Higher Secondary School, Banipark, Jaipur.	2	1	51	1	50
5.	Maharaja Girls Higher Secondary School, Gangauri Bazar, Jaipur.	1	1	31	-	-
6.	Model Girls Higher Secondary School, Gangauri Bazar, Jaipur.	1	-	-	1	31
7.	Girls Higher Secondary School, Adarsh Nagar, Jaipur.	1	-	-	1	21
8.	Vedik Girls Higher Secondary School, Adarsh Nagar, Jaipur.	1	1	18	-	-
	TOTAL	12	6	189	6	189

From the table No. 2 it is clear that number of students in experimental as well as in the control group was 189. Out of 189 students in the experimental group 89 were boys and 100 girls as against 87 boys and 102 girls in the control group.

In order to ensure that the groups of subjects, i.e. sections, assigned to the respective methods were comparable, means and standard deviations on all the independent variables were calculated for each section allotted to the two methods separately as well as for the entire groups.

Table No. 3

Means and standard deviations of scores of students on five independent variables.

Variables	Experimental group			Control group		
	Mean	S.D.	N	Mean	S.D.	N
1. Study habits	49.79	9.03	189	49.78	9.79	189
2. Rigidity-flexibility	13.46	2.13	189	13.32	2.34	189
3. Introversion-Extraversion	26.23	4.94	189	25.72	5.37	189
4. Previous achievement	21.51	6.06	189	21.09	7.36	189
5. Intelligence	45.84	12.27	189	45.92	12.12	189

Table No. 3 shows that the means and standard deviations of experimental and control groups on each of the five independent variables are highly comparable, almost the same. In order to further ascertain that the means of these groups do not differ, t test was applied which showed insignificant results.

Procedure of Instruction:

The two groups mentioned above were taught set theory by means of two methods of learning, viz., programmed instruction and conventional classroom method. As has been discussed elsewhere, the phrase "conventional classroom method" is meaningless unless defined clearly. In the present experiment, for example, six teachers were engaged for classroom teaching. If those teachers were allowed to teach set theory by the method they liked the best, the approach and methods would have differed from teacher to teacher and the end result also might have been different . In order to have a common approach of teaching, therefore, a meeting of those teachers was held, a fortnight before the commencement of the experiment. They were requested to teach sub topics in set theory to sections of class IX in their respective schools in six periods of the standard duration (40 minutes) in a specified order. Heuristic approach with five usual Herbatian steps, viz., preparation, presentation, comparison and abstraction, generalisation, and application, was agreed upon as a common approach to be followed by all. Other six teachers teaching in the respective schools were requested to supervise learning by school pupils through programmed instruction. They were experienced teachers and were made fully aware of the principles and technique of programmed instruction so that they did not prove to be over helpful and over interfering in the process of learning by the students of their respective sections. Pupils to be taught by programmed instruction were also made familiar with programmed material a day earlier to the actual learning sessions. For this purpose practice frames in theory of indices along with answersheets were given to the students by the same teachers.

Post achievement test on set theory was administered immediately after completion of instruction i.e. on the sixth day of the teaching programme. The delayed achievement test was administered to the students after two months.

CHAPTER - V

ANALYSIS OF THE DATA (A): ACHIEVEMENT SCORES

The aim of the present study, as discussed earlier, was to compare the learning outcomes in terms of post achievement scores and retention scores, in mathematics taught by two different methods of instruction, namely programmed instruction and usual classroom method. The present chapter discusses the effect of independent variables on achievement scores.

Analysis of variance with 2 x 2 x 2 factorial design was first applied to the post achievement scores of students classified on the basis of previous attainment in mathematics, study habits and methods of teaching (C-1). The scheme of classification has been represented in Diagram 5-1.

Diagram 5-1

Showing classification of 8 sub-groups formed on the basis of study habits (S_1 and S_2), previous attainment in mathematics (A_1 and A_2) under two learning conditions viz., programmed instruction (M_1) and usual classroom methods (M_2)

Learning conditions

- Programmed Instructions (M_1)
  - Study Habits(S)
    - Good (S_1)
    - Poor (S_2)
  - Pre-attain. in Maths (A)
    - High (A_1)
    - Low (A_2)
- Usual classroom method(M_2)
  - Study Habit(S)
    - Good (S_1)
    - Poor (S_2)
  - Pre. attain. in Maths(A)
    - High (A_1)
    - Low (A_2)

The result yielded by the analysis of variance indicating the main effects, and the first and second order interaction effects are presented in Table No. C.1.

Table No. C-1

Summary of analysis of variance of post achievement scores of students classified on the basis of methods of teaching, previous attainment and study habits.

Source of variation	Sum of squares	df	Mean square	f	Significance
Previous attainment in mathematics (A)	731.02	1	731.02	27.8	*
Study habits (S)	30.62	1	30.62	1.16	
Methods of teaching (M)	5175.62	1	5175.62	196.86	*
A x S	90.01	1	90.01	3.42	
A x M	12.11	1	12.11	.46	
S x M	176.41	1	176.41	6.71	*
A x S x M	30.61	1	30.61	1.16	
Within cells	3996.70	152	26.29	-	

* Significant at .01 level

The main effect:

The result presented in Table C-1 show that main effects of two variables, viz., previous attainment in mathematics and methods of teaching mathematics are significant. The F value for the main effect of previous attainment is 27.8 which is significant at .01 level. When the data are explored further it is found that students with higher previous attainment secure higher mean achievement scores than students with lower previous attainment scores. The mean achievement scores for high and low previous attainment group being 31.31 and 27.03 respectively.

The F value for the main effect of methods of teaching, also significant at .01 level, is 196.86. An examination of the mean scores shows that those who were taught by programmed instruction secured a mean score of 34.86 as against the score of 23.48 secured by those taught by the conventional classroom methods. The direction of difference between achievement scores favours programmed instruction.

The main effect of study habits on achievement scores of students is insignificant the F value being 1.16. This means that an average change in study habit scores does not bring a significant change in achievement scores of the subjects. The mean score of students with good study habits is, however, slightly higher than the mean score of students with poor study habits, the two means respectively being 29.81 and 23.73.

First order interaction effects:

The first order interaction between variables study habits and previous attainment in mathematics is insignificant, it's F value being 3.43. This shows that an average change in study habit scores combined with a change in previous attainment scores does not bring any meaningful change in achievement scores of the students. This can also be interpreted to mean that the main effect of previous attainment, found to be significant, is independent of any effect produced by the study habits on the achievement of the student concerned.

The interaction between variables previous attainment and methods of teaching is also insignificant, the F value is as low as .46. This implies that previous attainment and methods of teaching have no combined effect on the achievement scores of subjects, and that the main effects of previous attainment and method of teaching, each found to be significant at .01 level, stand out in their own right.

The interaction effect between study habits and methods of teaching is significant, the F value for this interaction effect being 0.71. The interaction has also been represented graphically (Cf. Figure C-1). For searching out the direction of this effect the means of achievement scores of four sub-groups have been summarised in Table No. C-1(a).

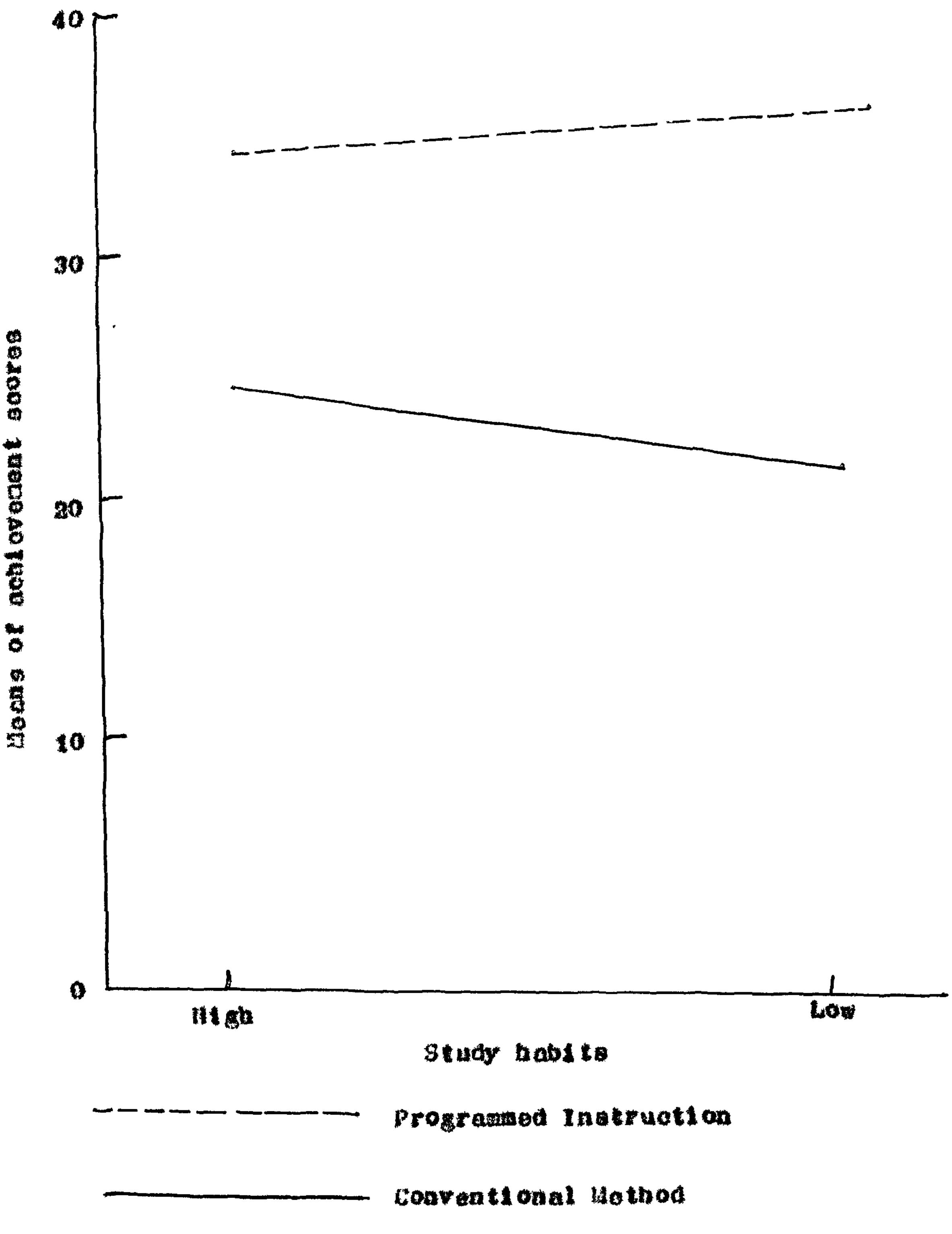


Figure C-1. Representing interaction between Study habits and Methods of teaching.

Table No. C-1(a)

Mean achievement scores of sub-groups S_1M_1, S_1M_2, S_2M_1 and S_2M_2.

Method of teaching		Study Habits S_1	Study Habits S_2
	M_1	34.25	35.4
	M_2	24.90	22.0

From table No, C-1(a) inference can be drawn that good study habits when combined with programmed instruction produce a more positive effect on achievement as compared to the effect it produce when combined with the conventional methods. It is interesting to note that students with poor study habits have performed better than those having good study habits with programmed instruction, the mean being 35.4 and 34.25 respectively. The difference is, however, very slight. Contrary to this, means of achievement scores of subjects having good and poor study habits and taught through conventional method are 24.9 and 22 respectively, the difference being in favour of good study habits combined with usual classroom method. In diagonal comparisons i.e. between the groups S_1M_1, S_2M_2! and S_2M_1, S_1M_2, the difference in mean achievement scores are 12.25 and 10.5 respectively. The higher difference between means of groups S_1M_1 and S_2M_2 showing that programmed instruction when combined with good study habits produce strikingly better results than conventional classroom method when combined with poor study habits.

Second order instruction effect:

The F value for the interaction effect of study habits, previous attainment and methods of teaching, being 1.16, gives insignificant results. This shows that an average change in study habit score with an average change in previous attainment scores in any direction does not affect the achievement whether taught by programmed instruction or by conventional method. Hence it can be concluded that the study habits, previous attainment in mathematics and methods of teaching combined in any possible way have no significant effect on the achievement.

In order to study the effect of combination of variables involving rigidity, study habits and methods of teaching (C-2) 8 cells of a table of analysis of variance were formed with equal number of students (the number being 10) in each cell. The plan for classifying the three variables has been reported diagrammatically in Diagram No. 8-2.

Diagram B-2

Showing classification of 8 sub groups formed on the basis of study habits (S_1 and S_2), rigidity (R_1 and R_2) under two learning conditions, viz., programmed instruction (M_1) and usual classroom method.

Learning conditions

- Programmed Instruction (M_1)
  - Rigidity (R)
    - High (R_1)
    - Low (R_2)
  - Study habits(S)
    - Good (S_1)
    - Poor (S_2)
- Usual classroom method (M_2)
  - Rigidity (R)
    - High (R_1)
    - Low (R_2)
  - Study habits(S)
    - Good (S_1)
    - Poor (S_2)

The results yielded by the analysis are presented in Table No. C-2.

Table No. C-2

Summary of analysis of variance of post achievement scores of students classified on the basis of methods of teaching, rigidity and study habits.

Source of variation	Sum of squares	df	Mean squares	F	Significance
Rigidity (R)	2.45	1	2.45	0.08	
Study habits (S)	8.45	1	8.45	0.30	
Methods of teaching (M)	2420.80	1	2420.80	88.80	*
R x S	12.80	1	12.80	0.46	
R x M	1.25	1	1.25	0.04	
S x M	10.45	1	10.45	0.38	
R x S x M	64.80	1	64.80	2.37	
Within cells	1963.20	72	27.26	-	

* Significant at .01 level

Main effect:

An examination of Table No. C-2 shows that the main effect of rigidity on the achievement of students is insignificant, the F value being as low as .08. The means of achievement scores of high and low rigidity subjects are 29.67 and 30.03 respectively. Thus rigidity has no effect upon the achievement scores of students.

The main effect of study habits on achievement scores of the subjects is also insignificant, the F value being .30. The mean achievement scores of subjects having good and poor study habits are 30.17 and 29.52, the difference again being negligible.

The main effect of types of instruction on achievement scores of the students is highly significant, the F value being as high as 88.9. A further examination of the data reveals that the means of achievement scores of subjects taught by programmed instruction and by usual classroom methods are 35.33 and 24.35 respectively indicating the fact that programmed instruction as a method of teaching is far superior to the usual classroom instruction.

First order interaxtion effect:

The interaction effect between variables rigidity and study habits on achievement is insignificant, the F value of

.46 being rather low. It will be recalled that neither of x these two variables shows its main effect upon achievement. Hence it can be concluded that the two variables namely rigidity and study habits neither individually nor when combined together, have any effect upon the achievement of the subjects.

The interaction effect between rigidity and methods of teaching upon achievement of subjects is also insignificant the F value, namely .04 being very low. This demonstrates that rigidity and methods of teaching have no interdependent effect on achievement.

The combined effect of study habits and methods of teaching is also insignificant, the F value which is .33, indicating the fact that an average change in rigidity scores with change in types of instruction does not bring any significant change in the achievement of the learners.

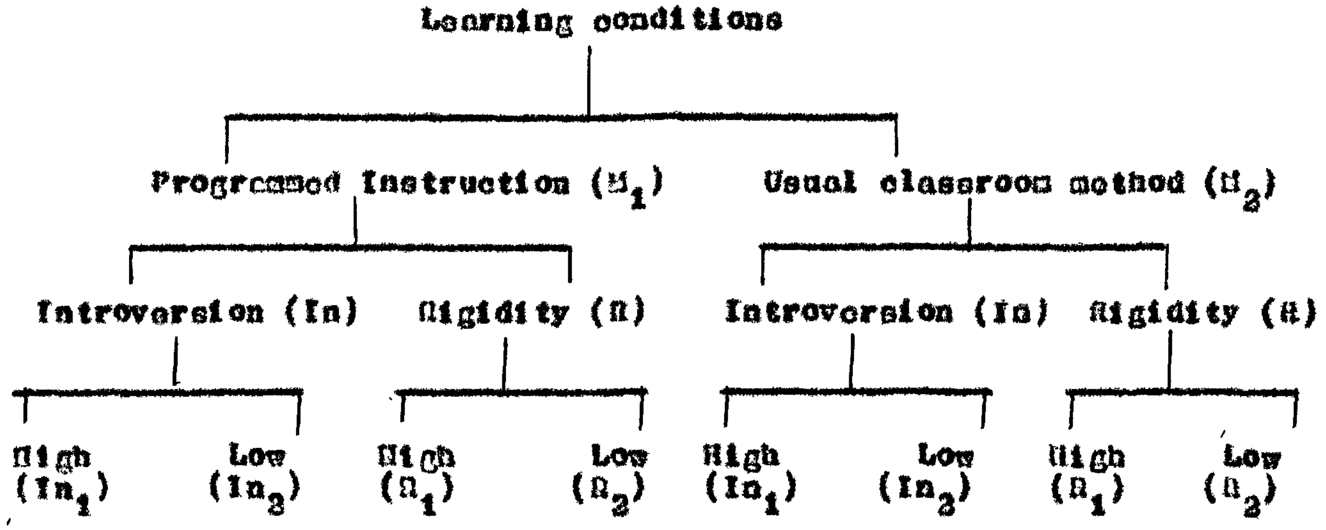
The Second order interaction effect:

The combined effect of the three variables viz., rigidity, study habits and methods of teaching upon achievement scores of the subjects is also insignificant the F value being 2.37. This indicates that the above three variables are independent of each other so far as achievement of the students is concerned.

The effect of such variables, as methods of teaching introversion and rigidity (C-3) on achievement scores of students were studied according to the following plan.

Diagram No. C-3

Showing classification of 8 sub-groups formed on the basis of introversion (In_1 and In_2), rigidity (R_1 and R_2) under two conditions of learning, viz., programmed instruction and conventional classroom method.



The results of the analysis of variance are summarized in Table No. C-3.

Table No. C-3

Summary of analysis of variance of post achievement scores of students classified on the basis of methods of teaching, introversion and rigidity.

Source of variation	Sum of squares	df	Mean squares	F	Signi- ficance
Introversion (In)	320.7	1	326.7	9.42	*
Rigidity (R)	22.53	1	22.53	0.66	
Methods of teaching (M)	2900.13	1	2900.13	85.40	*
In x R	38.54	1	33.54	1.11	
In x M	0.54	1	0.54	-	
R x M	108.04	1	108.04	4.84	**
In x R x M	12.02	1	12.02	0.34	
Within cells	3982.67	112	34.00	-	

* Significant at .01 level
** Significant at .05 level

<u>Main effects:</u>

The first three entries in the table are for the main effects of three independent variables, namely, rigidity, introversion and methods of teaching. The effect of rigidity on the degree of achievement in mathematics, the F value being .66, is insignificant. This leads to the conclusion that achievement varies independent of the variation in rigidity. The mean achievement scores for high and low rigid subjects are 30.01 and 29.15 respectively showing a slight insignificant difference in favour of rigidity.

The main effect of two of the three variables, namely introversion and methods of teaching are significant. The main effect of introversion, with an F value of 9.42, is significant at .01 level, establishing the fact that achievement in mathematics is to a large extent dependent upon this personality variable. When reference to the mean achievement scores for subjects high in introversion and low in introversion is made, the mean scores respectively being 31.23 and 27.93, it is revealed that subjects who score high on introversion learn better than those who score low on this variable.

The main effect of methods of teaching on achievement of learners, F value being 85.4 is also significant at .01 level. The mean achievement scores for subjects taught through programmed instruction is 34.56 as against the mean achievement score of 24.61 for those who received instruction through the conventional methods. The higher mean score for programmed instructional group shows that it is superior to the conventional method as far as achievement in mathematics is concerned.

First order interaction effects:

The combined effect of introversion and rigidity upon achievement scores of the subjects is insignificant, the F value being 1.11. This indicates that the effect of introversion on achievement is independent of the effect of rigidity which (as the overall result reveals) neither independently nor in combination with introversion, has any effect on achievement in mathematics.

The interaction effect of introversion and methods of teaching is also insignificant showing thereby that an average change in introversion scores combined with a change in methods of instruction does not produce any significant change in the achievement scores of the subjects.

The effect of interaction between rigidity and methods of teaching is significant at .05 level, the F value being 4.94 (Cf. Figure C-3). For finding out the direction of interaction effect the mean achievement scores for the four combined groups have been presented in Table No. C-3(a).

Table No. C-3(a)

Means of achievement scores of sub-groups R_1M_1, R_1M_2, R_2M_1 and R_2M_2.

Methods of teaching	Rigidity R_1	Rigidity R_2
M_1	33.8	35.3
M_2	26.23	23.0

From the above table inference can be drawn, the highest of the means of achievement scores being 35.3 (R_2M_1)

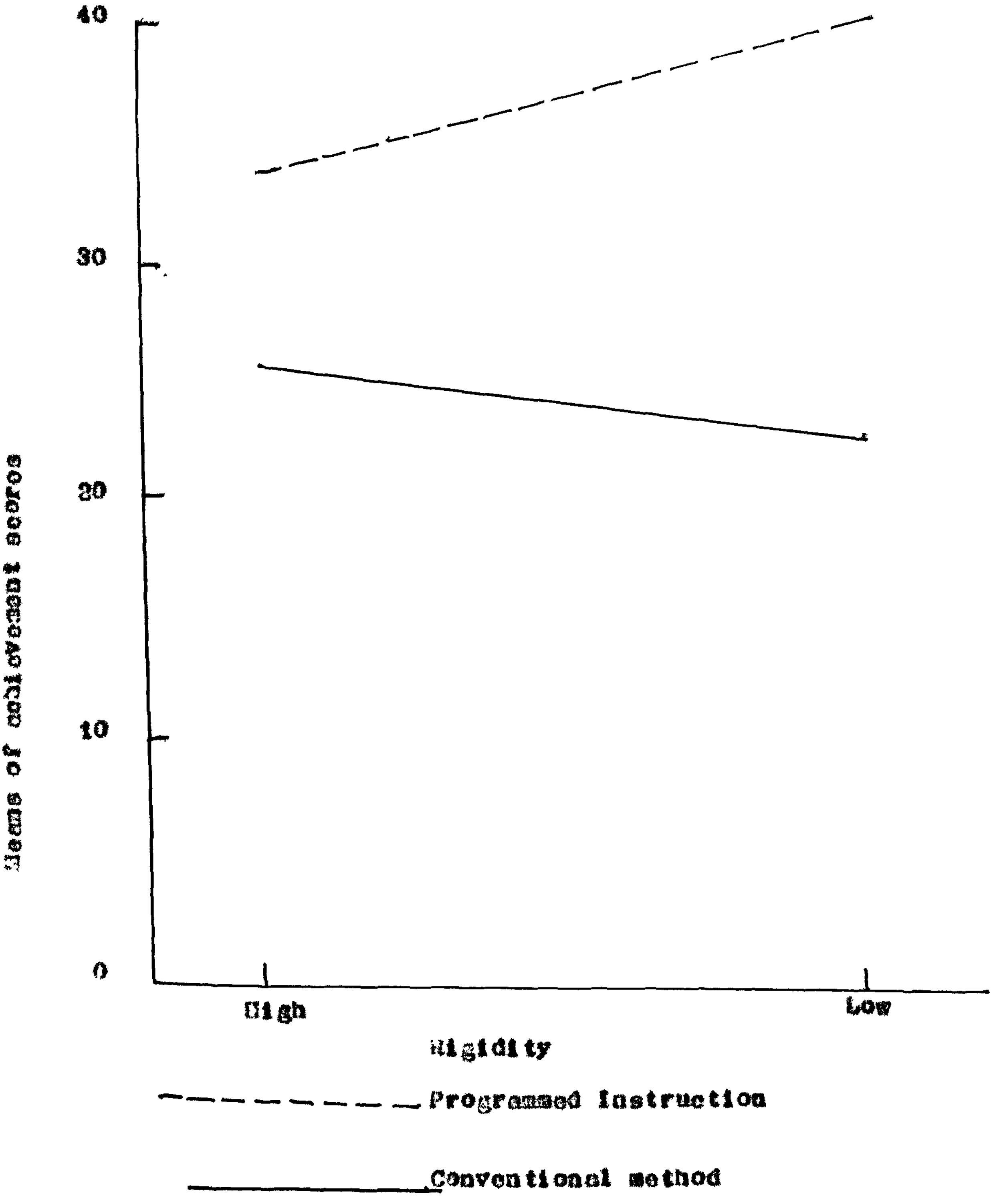


Figure E-2 Representing interaction between Rigidity and Methods of teaching.

and the lowest 23.1 (R_2M_2), that low rigidity when combined with programmed instruction leads to better achievement than low rigidity when combined with the usual classroom methods. Superiority of the programmed instruction over the usual classroom methods is maintained, however, even when the programmed instruction is combined with high rigidity. When the mean scores for subjects with high and low rigidity are compared in the context of programmed instruction it is revealed that low rigidity subjects when taught through programmed instruction score higher than high rigidity subjects taught by the same method. Contrary to this, high rigidity subjects achieve better than low rigidity subjects when taught by usual classroom methods. This trend is even more clearly revealed when a diagonal comparison is made. The two pairs of extreme group R_1M_1 - R_2M_2 and R_2M_1 - R_1M_2 show the difference of 10.8 and 9.1 between their means respectively. This confirms the fact that programmed instruction combined with any level of rigidity produces better effect on learning than the usual classroom methods. The comparison of all the means establish that the combined effect of rigidity and methods of instruction is in agreement with the understanding that those two variables combined together would produce a change in the learning outcomes of the subjects. They also confirm that although rigidity independently does not produce any significant effect upon learning outcome, it does so when combined with two types of methods.

The Second order interaction effects:

The F value for the joint effect of two personality variables, viz., introversion and rigidity, and the methods of teaching on the achievement scores of the subjects is insignificant, the F value being .34. This shows that an average change in introversion scores together with a corresponding average change in rigidity scores of the subjects taught either by programmed instruction or by the teacher through the usual classroom methods does not affect the achievement.

To determine the effect of another set three variables, namely, methods of teaching, intelligence and study habits of students (C-4) on their achievement in mathematics. The plan of analysis was as represented in the Diagram No. D-4.

Diagram No. D-4

Showing classification of eight sub groups formed on the basis of study habits (S_1 and S_2), intelligence (I_1 and I_2) under two conditions of learning viz., programmed instruction and conventional classroom method.

Learning conditions

- Programmed Instruction (M_1)
  - Study habits (S)
    - Good (S_1)
    - Poor (S_2)
  - Intelligence (I)
    - High (I_1)
    - Low (I_2)
- Conventional classroom method (M_2)
  - Study habits (S)
    - Good (S_1)
    - Poor (S_2)
  - Intelligence (I)
    - High (I_1)
    - Low (I_2)

The results obtained through the analysis have been summarized in Table No. C-4.

Table No. C-4

Summary of analysis of variance of post achievement scores of students classified on the basis of methods of teaching, intelligence and study habits.

Source of variation	Sum of squares	df	Mean squares	F	Significance
Study habits (S)	1.80	1	1.80	0.07	
Intelligence (I)	252.05	1	252.05	10.99	*
Methods of teaching (M)	2531.25	1	2531.25	110.39	*
S x I	1.80	1	1.80	0.07	
S x M	12.80	1	12.80	0.55	
I x M	22.05	1	22.05	0.96	
S x I x M	45.00	1	45.00	1.96	
Within cells	1651.20	72	22.93	-	

* Significance at 0.01 level

Main effects:

An examination of Table No. C-4 shows that the main effect of study habits, F value being .07, is insignificant. The means of achievement scores of the subjects with good study habits and poor study habits respectively being 29.87 and 29.57, are almost equal. The low value of F for the main effect of the study habits and the negligible difference between the mean achievement scores for the two levels of study habits show that achievement in mathematics is independent of the study habits of the students.

The main effect of intelligence on achievement is significant, the F value for the effect being 10.99. The students with high intelligence have secured the mean achievement score of 31.5 as against the mean of 27.95 for those having low intelligence. The direction of difference between the mean achievement scores establishes that subjects with higher intelligence have better achievement than subjects with lower intelligence.

The main effect for methods of teaching mathematics, F value being 110.30, is also highly significant. In the above analysis the mean achievement score for subjects taught by programmed instruction is 33.35 while the mean for those who were taught by the teacher through the conventional methods is 24.1, the extent and direction of the mean difference very clearly demonstrating the advantage of programmed instruction over the conventional methods.

<u>The first order interaction effects:</u>

For searching out the combined effects on the level of achievement of student (i) of study habits and methods of teaching, (ii) of study habits and intelligence, and

(iii) of intelligence and methods of teaching the first order interaction effects of these pairs of variables were worked out. Results as summarised in Table C-4 reveals that the interaction effect of study habits and intelligence upon the achievement scores of the subjects is insignificant, the F value being .07. This demonstrate that an average change in study habits scores with corresponding change in intelligence scores does not bring about any significant changes in achievement scores of the students.

The combined effect of study habits and methods of teaching upon the achievement scores of subjects is also insignificant, the F value being .55. This indicates that the achievement of students remains unaffected by the varying combinations of good and bad study habits and programmed instruction and the conventional classroom methods.

The interaction effect of the variables intelligence and methods of teaching upon the achievement scores of the subjects is also insignificant, the F value being .96. This shows that levels of intelligence of students and types of method through which instruction is imparted to them are independent of each other so far as their effect on achievement is concerned.

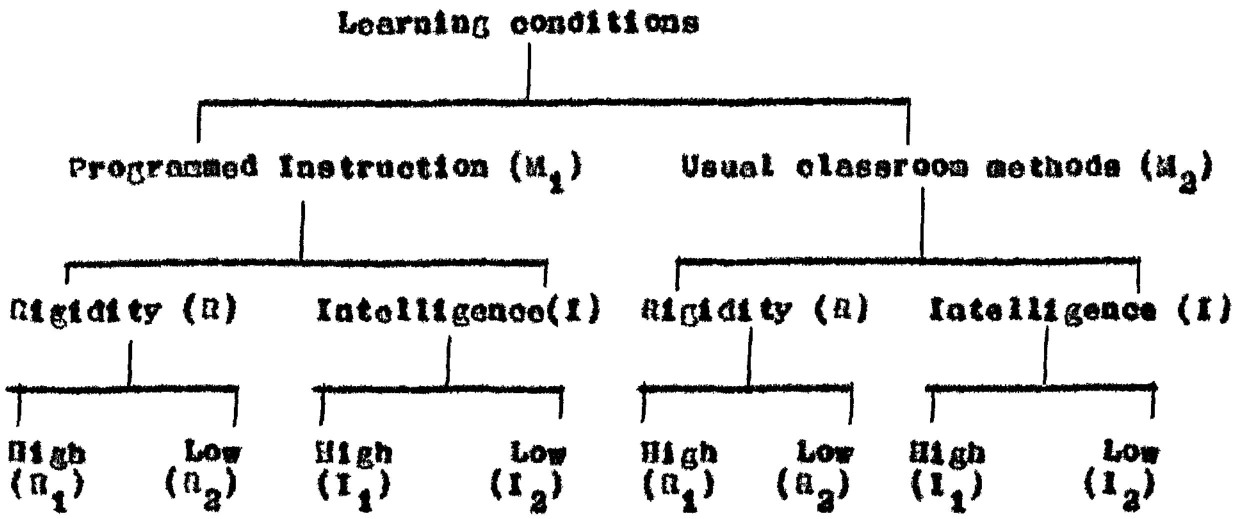
<u>The second order interaction effect:</u>

The F value for the joint effect of study habits, intelligence and methods of teaching is 1.90, which is insignificant. This may be interpreted to mean that methods of instruction, study habits and intelligence in combination with each other do not have any effect on achievement.

The plan for studying the effect of a combination of such variables as intelligence, rigidity and methods of teaching (C-5) is illutrated with the help of following diagram.

Diagram No. B-5

Showing classification of eight sub groups formed on the basis of rigidity (R_1 and R_2) intelligence (I_1 and I_2) under two conditions of learning, viz., programmed instruction and conventional classroom methods.



The results obtained have been summarised in Table No. C-5.

Table No. C-5

Summary of analysis of variance of post achievement scores of students classified on the basis of method of teaching, intelligence and rigidity.

Source of variation	Sum of squares	df	Mean square	F	Signi-ficance
Rigidity (R)	68.45	1	68.45	2.44	
Intelligence (I)	186.05	1	186.05	6.65	**
Methods of teaching (M)	2247.20	1	2247.20	80.4	*
R x I	0.45	1	0.45	-	
R x M	33.80	1	33.80	1.2	
I x M	1.80	1	1.80	-	
R x I x M	16.20	1	16.20	0.57	
Within cells	2012.00	72	27.94	-	

* Significant at .01 level
** Significant at .05 level

Main effect:

An examination of the Table No. C-5 reveals that the effect of rigidity on achievement of students is insignificant. The achievement scores for students with high and low rigidity are 31.45 and 29.6 respectively indicating thereby that high rigid students achieve a little higher than low rigid students, though the difference is not meaningful statistically.

The main effect of intelligence of subjects on achievement scores is significant at .05 level, F value being 6.65. The student with high and low intelligence have secured mean achievement scores of 32.05 and 29.0 which means that the high intelligence group of students have achieved higher than low intelligence group. This clearly indicates that achievement of students is dependent upon their intelligence level.

The effect of the types of method upon the achievement scores of the subjects is highly significant the F value being 80.4 and the level of significance .01. The means of achievement scores of subjects taught by the programmed instruction and the usual classroom methods are 35.82 and 25.22 respectively, the mean of achievement scores for programmed instruction group being much higher than that for the conventional classroom instruction groups. This demonstrates the superiority of programmed instruction over the usual classroom instruction.

The first order interaction effects:

The combined effect of two variables, namely, rigidity and intelligence, upon the achievement scores of the subjects is insignificant, the F value being .45. The main effect of intelligence being significant. This result may be interpreted to mean that the effect of intelligence upon achievement is independent of rigidity.

The interaction effect of rigidity and types of instruction upon the level of achievement of the subjects is also insignificant, the F value being as low as 1.2. This shows that rigidity does not have any effect on achievement either alone or in combination with any of the two methods of teaching and also that the positive effect of programmed instruction is independent of the level of rigidity of the student.

The combined effect of intelligence and methods of teaching upon the achievement scores of the subjects is also insignificant. It is interesting to note that the main effects of both the variables were significant but the interaction effect is insignificant indicating that intelligence and methods of teaching affected levels of achievement independent of each other.

The second order interaction effect:

The combined effect of rigidity, intelligence and methods of teaching upon the achievement scores of the subjects is also insignificant, the F value being .57. This shows that variables rigidity, intelligence and methods of teaching are independent of each other so far their effect on achievement of students is concerned.

In order to examine the effect of variables introversion, intelligence and methods of teaching on achievement scores of the students,(C-6) the data was classified according to the plan given in Diagram No. B-6.

Diagram No. B-6

Showing classification of eight sub groups formed on the basis of introversion, intelligence under two conditions of learning, viz., programmed instruction and conventional classroom method.

Learning conditions

- Programmed Instruction (M_1)
  - Introversion (In)
    - High (In_1)
    - Low (In_2)
  - Intelligence (I)
    - High (I_1)
    - Low (I_2)
- Usual classroom instruction (M_2)
  - Introversion (In)
    - High (In_1)
    - Low (In_2)
  - Intelligence (I)
    - High (I_1)
    - Low (I_2)

The results obtained through the analysis are presented in Table No. C-6.

Table No. C-6

Summary of analysis of variance of post achievement scores of students classified on the basis of methods of teaching, introversion and intelligence.

Source of variation	Sum of squares	df	Mean squares	F	Signi-ficance
Introversion (In)	217.8	1	217.8	10.52	*
Intelligence (I)	460.8	1	460.8	22.60	*
Methods of teaching (M)	2808.05	1	2308.05	123.89	*
In x I	3.20	1	3.20	-	
In x M	1.25	1	1.25	-	
I x M	36.45	1	36.45	1.76	
In x M x I	22.05	1	22.05	1.06	
Within cells	1490.40	72	20.70	-	

* Significance at .01 level

Main effect:

Table No. C-6 reveals that the main effect of introversion on the level of achievement of the subjects learning mathematics is highly significant, the F value being 10.52. The means of achievement of students having high and low introversion scores are 32.65 and 29.35 respectively indicating that introverts achieve better than extraverts while learning mathematics. This also leads to the conclusion that introversion scores have positive relationship with achievement scores of the students.

The effect of intelligence on achievement scores of students is also significant, the F value being 22.60, at .01 level. The means of achievement scores of high and low intelligent students are 33.4 and 23.6 respectively showing that the achievement of highly intelligent students is higher than that of students with low intelligence. This establishes the fact that achievement in mathematics is to a large extent depends upon the intelligence of the learners.

The main effect of type of instruction on the achievement scores of the student is, again, significant at .01 level the F value being 128.89. The mean achievement score of students taught by programmed instruction is 30.77 as against the mean of 25.22 for students taught by the usual classroom methods, the former being higher than the latter. This shows the superiority of programmed instruction over classroom instruction.

First order interaction effects:

The combined effect of introversion and intelligence on the achievement scores of the subjects is insignificant. As mentioned above introversion and intelligence have shown significant main effects upon achievement. This lack of significance of interaction effect of the two variables further establishes that each of them has an independent effect on achievement.

The interaction effect of introversion and methods of teaching on the level of achievement of the students is also insignificant. Again, the two variables do have separate significant effect on the achievement of the subjects, but when combined together, they do not have any effect upon achievement. Hence the conclusion can be drawn that so far as their effect on achievement is concerned two variables are independent of each other.

The interaction effect of intelligence and methods of teaching on the achievement scores of the subjects is insignificant showing thereby that those two variables are independent of each other in their effect on achievement.

The second order interaction effects:

The combined effect of all the three variables, namely introversion, intelligence and methods of teaching on the achievement of students is also insignificant, the F value being 1.06. This confirms the conclusion that these three variables separately affect the level of achievement of the students, and their effect on achievement is independent of each other.

To determine the effect of three variables, namely, rigidity, previous attainment in mathematics and methods of instruction (C-7) on the achievement scores of the subjects eight sub groups were formed according to the following diagram.

Diagram No. B-7

Showing classification of 8 sub groups formed on the basis of rigidity (R_1 and R_2), previous attainment (A_1 and A_2) under two conditions of learning, viz., programmed instruction and conventional classroom methods.

- Learning conditions
  - Programmed Instruction (M_1)
    - Rigidity (R)
      - High (R_1)
      - Low (R_2)
    - Pre attainment (A)
      - High (A_1)
      - Low (A_2)
  - Conventional methods (M_2)
    - Rigidity (R)
      - High (R_1)
      - Low (R_2)
    - Pre attainment (A)
      - High (A_1)
      - Low (A_2)

The main effects, first order interactions and second order interaction yielded by the analysis are presented in Table No. C-7.

Table No. C-7

Summary of analysis of variance of post achievement scores of students classified on the basis of methods of teaching, rigidity and previous achievement.

Source of variation	Sum of squares	df	Mean square	F	Signi- ficance
Rigidity (R)	21.68	1	21.08	.87	
Previous attainment (A)	785.41	1	785.41	31.50	*
Methods of teaching (M)	3597.08	1	3597.08	144.50	*
R x A	9.07	1	9.07	.36	
R x M	279.07	1	279.07	11.21	*
A x M	205.40	1	205.40	8.25	*
R x A x M	49.43	1	49.42	1.98	
Within cells	2787.20	112	24.88	-	

* Significant at .01 level

Main effects:

An examination of Table No. C-7 shows that the main effect of rigidity (F value being .87) is insignificant. The means of achievement scores of high and low rigidity students are 29.25 and 30.1 respectively. This shows that a very negligible difference exists between the means.

The main effect of previous attainment in mathematics, F value being 31.56, is significant. The means for subjects with good and poor previous attainment are 32.23 and 27.11 respectively. Hence it can be concluded that this variable has a positive effect upon achievement of the subjects.

The main effect of methods of teaching (F value being 144.5) is also significant. The mean achievement scores of students taught by programmed instruction and usual classroom method are 35.15 and 24.2 respectively demonstrating the fact that programmed instruction as a method of teaching is superior to usual classroom instruction.

First order interaction effects:

The interaction effect of variable rigidity and previous attainment is insignificant, the F value being .30 meaning thereby that the combined effect of the two variables on the achievement of students is not meaningful. As previous attainment has significant main effect on achievement of students, the lack of significance of interaction effect of the two variables further establishes that previous achievement has an independent effect on achievement.

The interaction effect between rigidity and methods of teaching is significant, the F value being 11.21 (Cf. Figure E-3). Mean scores for different combinations of

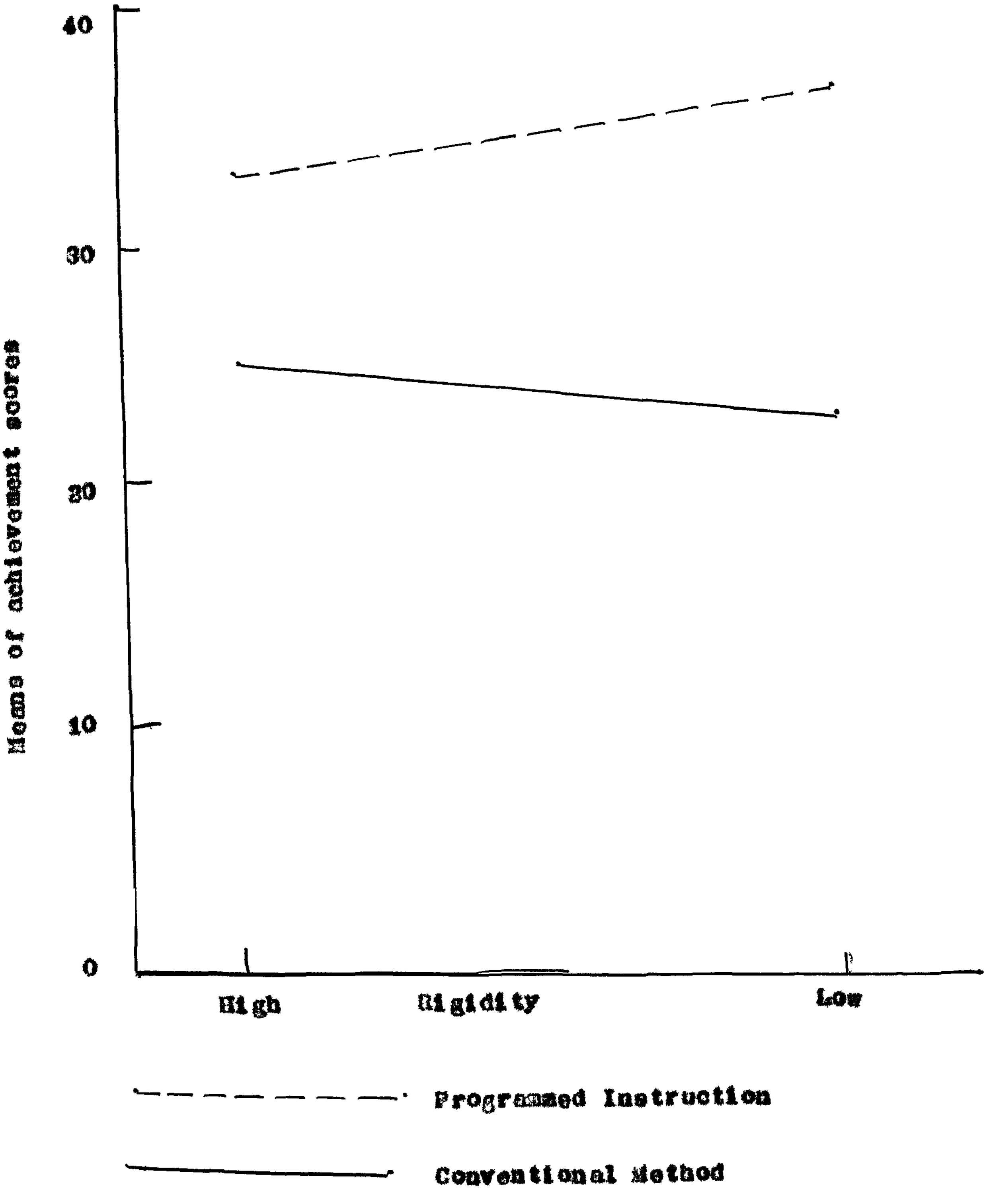


Figure 3-3. Representing interaction between Rigidity and Methods of teaching.

methods of instruction and rigidity were calculated and are placed in Table No. C-7(a).

Table No. C-7(a)

Means of achievement scores of sub-groups R_1M_1, R_1M_2, R_2M_1 and R_2M_2

Methods of teaching	Rigidity R_1	Rigidity R_2
M_1	33.2	37.1
M_2	25.3	23.1

Table No. C-7(a) reveals that highest amongst the means of achievement scores is 37.1 (R_2M_1 sub group) and the lowest being 23.1 for R_2M_2 sub group. This shows that low rigidity with programmed instruction is superior to all the other sub groups. When the means of achievement scores for subjects with high and low rigidity are compared, it is revealed that low rigidity subjects when taught with programmed instruction achieve higher than those having high level of rigidity but taught by the same method of instruction. The variable rigidity as main effect was found to be insignificant, but it's interaction with methods of teaching being significant shows that the two variables affect the achievement level of students.

The first order interaction effect of variables previous attainment in mathematics (A) and methods of teaching (M) is significant at .01 level the F value being as high as 8.25 (Cf. Figure E-4). This implies that an average change in previous attainment scores with simultaneous change in methods of teaching brings changes in achievement scores of the students. The means for sub groups on high previous attainment-programmed instruction, high previous attainment-usual classroom method, low previous attainment-programmed instruction, and low previous attainment-usual classroom method have been calculated and placed in Table No. C-7(b).

Table No.C-7(b)

Showing means of achievement scores of sub groups A_1M_1, A_1M_2, A_2M_1 and A_2M_2.

		Prev. attainment	
		A_1	A_2
Methods of teaching	M_1	36.4	33.9
	M_2	28.04	20.33

The Table No. C-7(b) reveals the fact that programmed instruction has emerged out to be a better method for those having high previous attainment in mathematics. This also shows that a positive relationship exists between previous

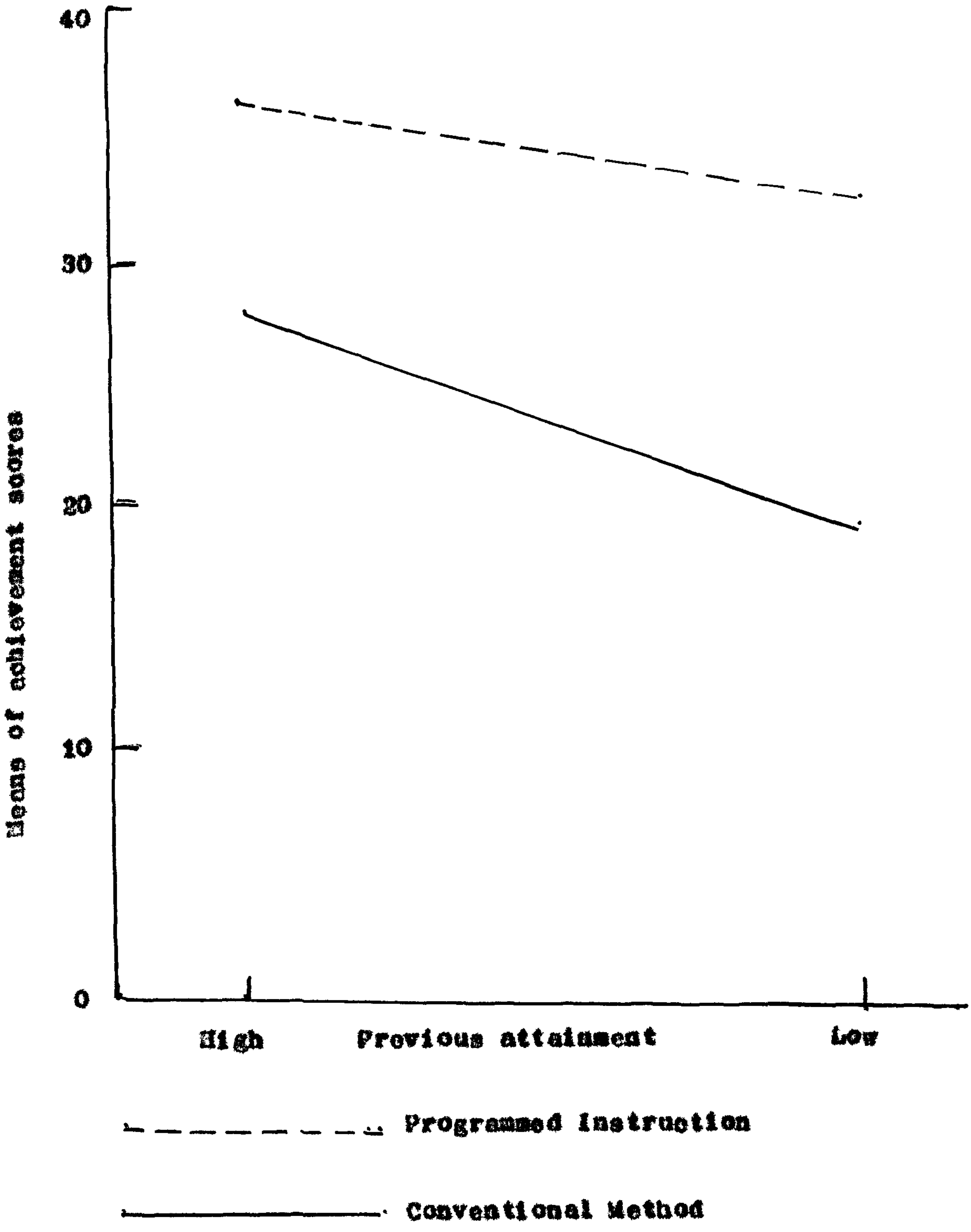


Figure C-4. Representing interaction between Previous Attainment and Methods of teaching.

attainment in mathematics and methods of instruction so far as achievement scores are taken into consideration.

The F value for the combined effect of rigidity, previous attainment and methods of teaching is 1.98, which is insignificant showing thereby that these three variables do not have any combined effect on the achievement scores of the students.

In order to examine the effect of three variables, namely previous attainment in mathematics, introversion and methods of teaching (C-8) on the achievement scores of the subjects the data was classified according to the following plan.

Diagram No. 5-3

Showing classification of 8 sub groups formed on the basis of previous attainment (A_1 and A_2), introversion (In_1 and In_2) under two learning conditions, viz., programmed instruction and conventional classroom methods.

Learning conditions

- Programmed instruction (M_1)
  - Previous attainment (A)
    - High (A_1)
    - Low (A_2)
  - Introversion (In)
    - High (In_1)
    - Low (In_2)
- Conventional Methods (M_2)
  - Previous attainment (A)
    - High (A_1)
    - Low (A_2)
  - Introversion (In)
    - High (In_1)
    - Low (In_2)

The results obtained through the analysis have been summarised in Table No. C-6.

Table No. C-6

Summary of analysis of variance of post achievement scores of students classified on the basis of method of teaching, introversion and previous attainment.

Source of variation	Sum of squares	df	Mean squares	F	Signi-ficance
Introversion (In)	84.05	1	84.05	3.65	
Previous attainment (A)	186.05	1	186.05	8.09	*
Methods of teaching (M)	4032.80	1	4032.80	175.56	*
In x A	11.25	1	11.25	.48	
In x M	12.80	1	12.80	.55	
A x M	16.20	1	16.20	.70	
In x A x M	16.20	1	16.20	.70	
Within cells	1654.20	72	22.97	-	

* Significant at .01 level

Main effects:

An examination of Table No.C-6 shows that the main effect of introversion is insignificant, the F value being 3.65. The means of achievement scores of the subjects having high and low introversion scores respectively are 32.2 and

30.15. The high introverts have secured higher than low introverts but the difference as the statistical result show, is not significant.

The main effect of previous attainment in mathematics on the achievement of the students is significant with an F value of 8.09. The students with high previous attainment in mathematics have secured the mean achievement score of 32.7 as against the mean of 29.05 for those having low previous attainment. The direction of difference between the means of achievement scores establishes that subjects with higher previous attainment have better achievement than subjects with poor previous attainment.

The main effect for methods of teaching, F value being 175.36, is again significant. The analysis reveals that the mean achievement score for subjects taught by programmed instruction is 33.27 while the mean for those who were taught by the teacher through the conventional methods is 24.07. The extent and direction of the difference between the two means clearly demonstrate the advantage of programmed instruction over classroom methods.

The first order interaction effects:

For searching out the combined effect of the level of achievement of the subjects (i) of introversion and previous attainment, (ii) of introversion and methods of teaching, and (iii) of previous attainment and methods of teaching the first order interaction effects of these pairs of variables were worked out.

Results as summarised in Table C-8 reveal that the interaction effect of introversion and previous attainment in mathematics is insignificant, the F value being .48. This demonstrates that an average change in introversion scores combined with a change in previous attainment scores does not bear any significant effect on achievement scores of the subjects.

The combined effect of introversion and methods of teaching on the achievement scores of subjects is also insignificant, the F value being .55. This indicates that the achievement of students remains unaffected by the varying combinations of high and low introversion, programmed instruction and conventional methods.

The interaction effect of the variables previous attainment in mathematics and methods of teaching on the achievement scores of subjects is also insignificant, the F value being .70. Even though the main effects of the above two variables were significant at .01 level; yet when combined together they do not show any effective relationship with the achievement of the students.

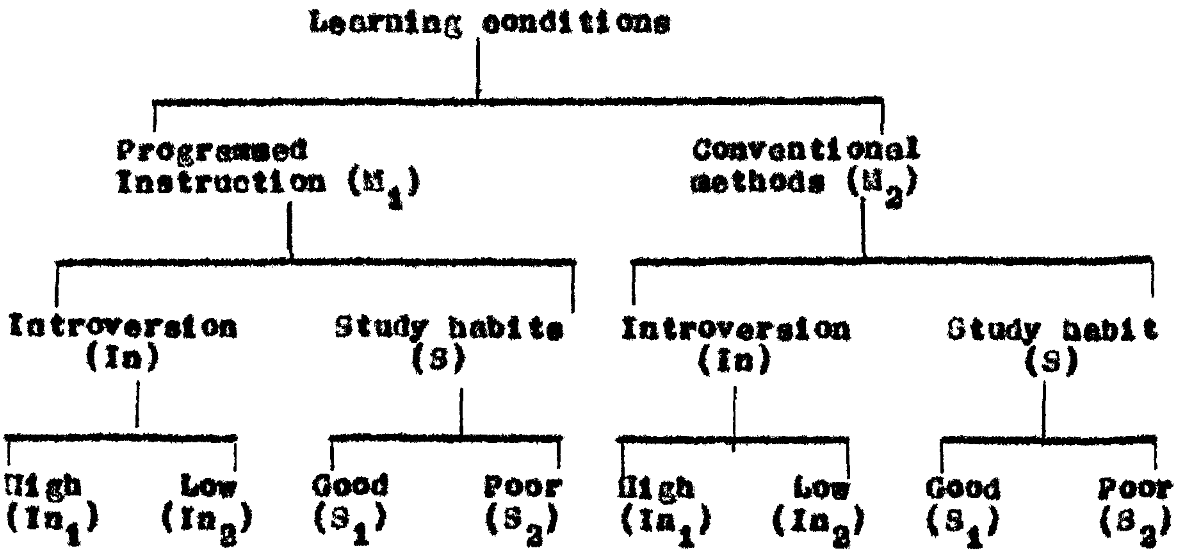
The second order interaction:

The F value for the joint effect of introversion, previous attainment and methods of instruction is .70, which is insignificant. This may be interpreted to mean that these three variables in combination with each other do not have any effect on achievement.

To determine the effect of three variables, namely, methods of instruction, introversion and study habits (C-9) on achievement the data was arranged according to the diagram given below.

Diagram No. B-9

Showing classification of eight sub groups formed on the basis of introversion (In_1 and In_2), study habits (S_1 and S_2) under two conditions of learning, viz., programmed instruction and conventional classroom methods.



The results of the analysis of variance are summarised in Table No. C-9.

Table No. C-9

Summary of analysis of variance of post achievement scores of students classified on the basis of methods of teaching, introversion and study habits.

Source of variation	Sum of squares	df	Mean squares	F	Significance
Introversion (In)	931.61	1	931.61	39.8	*
Study habits (S)	621.61	1	621.01	26.61	*
Methods of teaching (M)	904.51	1	904.51	33.72	*
In x S	.02	1	.02	-	
In x M	15.32	1	15.32	.65	
S x M	3.62	1	3.62	-	
In x S x M	726	1	726	31.07	*
Within cells	1682.10	72	23.36	-	

* Significant at .01 level

<u>Main effects:</u>

The main effect of introversion on the level of achievement of the subjects is significant, F value being 39.88. The means of achievement scores of high and low introversion subjects are 33 and 26.17, indicating that high introversion student achieve more than low introversion subjects. This establishes the fact that achievement in mathematics to a large extent depends upon this personality variable.

The main effect on achievement scores of the subjects of study habits, F value being 26.01, is also significant. The achievement mean of students having good study habits is 33.37 as against 26.6 for those having poor study habits. This shows achievement scores of students are greatly influenced by the study habits of the subjects.

The main effect for methods of teaching on the achievement scores of students is significant, F value being 38.72 establishing the fact that achievement in mathematics to a large extent depends upon types of instruction. When reference is made to the mean achievement scores of programmed and usual classroom methods, (M_1 = 32.95 and M_2 = 26.22), leads to the conclusion that achievement varies with the variations in types of instruction. Also, superiority of programmed instruction over usual classroom method has been again established.

First order interaction effect:

The combined effect of introversion and study habits on the achievement scores of students is insignificant. This indicates that the achievement scores of students are independent of introversion combined with study habits.

The interaction effect of introversion and methods of teaching on the level of achievement of the students is insignificant. This indicates that achievement scores remains unaffected by the various combination of introversion and types of instruction.

The combined effect of study habits and methods of teaching on the achievement scores of students is also insignificant. This shows that an average change in study habit scores with corresponding change in methods of instruction do not bring any significant change in achievement scores.

<u>The second order interaction:</u>

The combined effect of variables introversion, study habits and methods of teaching on the achievement scores of student is significant, F value being 31.07. The means of achievement scores of various combinations of the above variable are summarised in Table No. C-9(a).

Table No. C-9(a)

Means of achievement scores of sub-groups $In_1M_1S_1$, $In_1M_2S_1$, $In_1M_1S_2$, $In_1M_2S_2$, $In_2M_1S_1$, $In_2M_2S_1$, $In_2M_1S_2$ and $In_2M_2S_2$

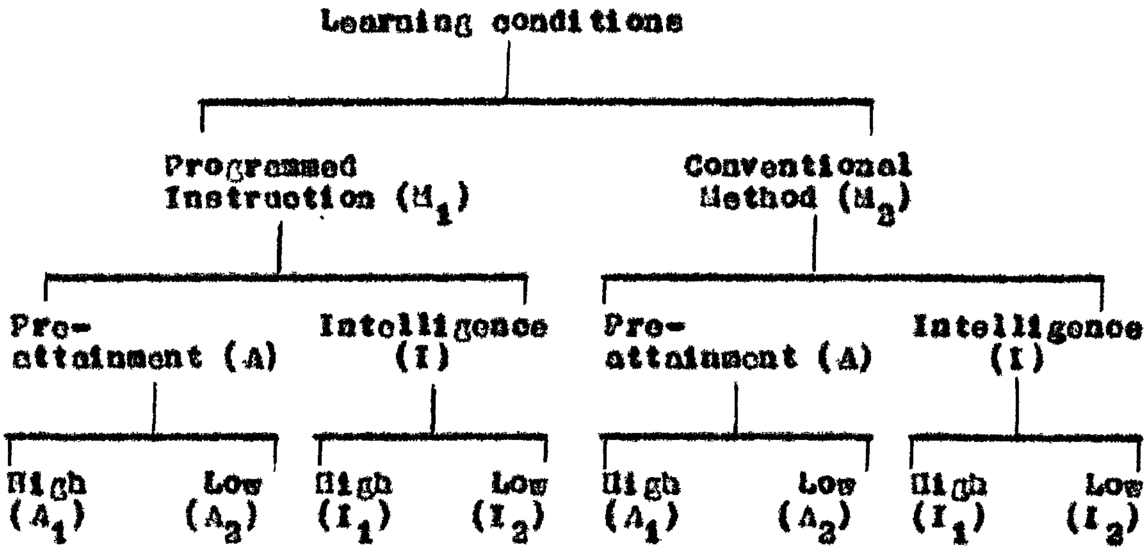
Study habits		Introversion In_1	Introversion In_2
S_1	M_1	36.7	35.2
	M_2	34.7	22.0
S_2	M_1	33.9	23.0
	M_2	23.7	23.6

A close examination of Table No. C-9(a) reveals that the mean of achievement for sub-group $S_2M_1In_1$ is the highest whereas for sub-group $S_2M_2In_2$ is the lowest. It is interesting to note that students with poor study habits, high introversion and taught by programmed instruction have mean of achievement score (35.0) almost equal to mean (33.7) of student having good study habits, high introversion and taught by the same method. From Table No. C-9(a) the conclusion can be drawn that achievement scores of students are affected by the combined effect of variables introversion, study habits and methods of teaching.

To determine the effect of previous attainment in mathematics, intelligence and methods of teaching (C-10) on the level of achievement eight sub groups depicted in the following diagram, were obtained.

Diagram No. D-10

Showing classification of eight sub-groups formed on the basis of pre-attainment (A_1 and A_2), intelligence (I_1 and I_2) under two conditions of learning viz., programmed instruction and conventional classroom methods.



The results obtained have been summarised in Table No. C-10.

Table No. C-10

Summary of analysis of variance of post achievement scores of students classified on the basis of method of teaching, previous attainment and intelligence.

Source of variation	Sum of squares	df	Mean square	F	Significance
Previous attainment (A)	252.05	1	252.05	8.33	*
Intelligence (I)	186.05	1	186.05	6.18	**
Methods of teaching (M)	1462.05	1	1462.05	48.65	*
A x I	105.80	1	105.80	3.52	
A x M	.80	1	.80	-	
I x M	96.80	1	96.80	3.22	
A x I x M	130.05	1	130.05	4.32	**
Within cells	2164.20	72	30.05	-	

* Significant at .01 level
** Significant at .05 level

Main Effect:

Table No. C-10 shows that out of three main effects, the main effects of previous attainment and methods of teaching is significant at .01 level, the F value being 8.36 and 48.65 respectively. This fact is further established by comparing the means of the achievement scores of dichotomised data. The mean achievement scores of high previous attainment group is 32.87 whereas mean achievement score for low attainment group is 29.42. This confirms the fact that achievement scores and previous attainment of students are positively related with each other.

The main effect of methods of teaching, as pointed out earlier, happens to be significant. An examination of the data reveals the fact that the students who were taught by programmed instruction had secured achievement - mean of 33.47 as against 28.92 for those who received instruction through conventional manner. This establishes that methods of teaching affect the achievement scores of students to a great extent.

The main effect of intelligence on the achievement scores of the students is significant at .05 level, the F value being 6.19. The means of achievement scores of subjects with high and low intelligence are 32.72 and 29.67 respectively showing thereby that level of intelligence of the learner affects their achievement scores.

First order interaction effect:

The first order interaction effect on the achievement scores of the subjects, of intelligence and previous attainment is insignificant, F value being 3.52. This shows that these two variables do not have any combined effect on the achievement scores of the learners.

The combined effect of previous attainment in mathematics and methods of teaching on the achievement scores of the students is insignificant, the F value being .08. This implies that these two variables when taken individually affects the achievement scores, but when combined do not yield any significant effect on the level of achievement.

The interaction effect of intelligence and methods of teaching on the achievement scores of the learners is also insignificant, F value being 3.22, demonstrating that joint effect of these two variables do not yield any significant result on achievement.

Second order interaction effect:

The F value for the combined effect of previous attainment, methods of teaching and intelligence on the achievement scores of the student is significant at .05 level, the F value being 4.32. In order to explore the data further means of achievement scores of all the eight sub groups, formed by various combinations of these three variables, were calculated and are presented in Table No. C-10(a).

Table C-10(a)

Showing means of achievement scores of sub groups $A_1M_1I_1$, $A_1M_2I_1$, $A_1M_1I_2$, $A_1M_2I_2$, $A_2M_1I_1$, $A_2M_2I_1$, $A_2M_1I_2$ and $A_2M_2I_2$.

Achievement

		A_1	A_2
I_1	M_1	42.2	34.0
	M_2	29.1	25.6
I_2	M_1	32.1	33.6
	M_2	23.5	24.5

The Table C-10(a) reveals that the mean of programmed instructional group combined with high intelligence and high achievement is the highest (42.2) amongst all means whereas the lowest mean .i.e. 24.5, belongs to students poor in previous attainment, low intelligence and taught by conventional method. This further gives evidence that three variables have joint effect on the achievement scores of the students.

C H A P T E R - VI

ANALYSIS OF THE DATA (B) - RETENTION SCORES

In order to compare the effectiveness of the two methods of teaching being studied i.e. programmed instruction and the usual classroom method in relation to retention of the learned material by student of "Set Theory" in mathematics the method of analysis of variance has been applied in the manner as described earlier in relation to post test achievement scores of the students. In this case also the comparison of the method of teaching was made in the context of the five learners characteristics, namely, intelligence, introversion, rigidity, study habits, and previous attainment in mathematics which along with methods were treated as five additional independent variables. Here, again, out of the five additional variables two have been taken for analysis at a time, while methods of teaching have been included in all analyses. This has resulted in ten analyses in relation to retention scores as well. The plan for classification of variables into two levels has also been the same as followed in the analysis of achievement scores.

For finding out the effect of methods of teaching, previous attainment in mathematics and study habits on the retention scores of the students a 2 x 3 x 2 factorial design with analysis of variance was used. In course of analysis main effects of the independent variables, and first and second order interactions were calculated. The results obtained from this analysis have been summarised in Table R-1.

Table No. R-1

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching previous attainment and study habits.

Source of variation	Sum of square	df	Mean square	F	Significance
Previous attainment in mathematics (A)	851.01	1	851.01	25.6	*
Study habits (S)	327.70	1	327.70	9.86	*
Methods of teaching (M)	1193.56	1	1193.56	35.90	*
S x A	91.50	1	91.50	2.75	
S x M	12.65	1	12.65	0.38	
A x M	4.55	1	4.55	0.13	
S x A x M	327.77	1	327.77	9.86	*
Within cells	5053.93	152	33.24	-	

* Significant at .01 level

The analysis of variances reveals that the main effects of all the three variables, viz., previous attainment, study habits and methods of teaching are significant at .01 level, the F values being 25.6, 9.86 and 35.9 respectively. By further exploring the data, it has been found that mean retention scores of high previous attainers is 24.98 as against 20.37 for low previous attainers, the former being higher than the later. This shows that high previous attainment group retain better and higher than low previous attainment group.

The sub groups good study habits and poor-study habits have secured retention means as 24.11 and 21.25 respectively. The difference and direction between these means shows that students with good study habits retain better than those having poor study habits.

The means of retention scores of students taught by programmed instruction and usual method of instruction are 25.41 and 19.95 respectively. The difference between these means is 5.46 in favour of programmed instructional group. This shows that students taught by programmed instruction not only achieve better than usual classroom methods, but also retain higher than this group.

The first order interaction effects:

The F value for the interaction effects of study habits and previous attainment in mathematics, study habits and methods of teaching, and previous attainment and methods of teaching on retention scores of students are 2.75, .38 and .13 respectively. These values are insignificant showing thereby that these combinations of variables do not yield any meaningful relationship with the retention scores of the students and that their main effect is independent of each other.

The second order interaction effect:

The F value for the combined effect of study habits, previous attainment in mathematics and methods of teaching is 9.86, which is significant at .01 level. This shows that retention scores vary significantly with the different combinations of the three variables. In order to explore the data further, means of retention scores for different combinations of the variables concerned were calculated and have been summarised in Table No. R-1(a).

Table No. 8-1(a)

Showing means of retention scores of sub groups $S_1A_1M_1$, $S_1A_1M_2$, $S_1A_2M_1$, $S_1A_2M_2$, $S_2A_1M_1$, $S_2A_1M_2$, $S_2A_2M_1$ and $S_2A_2M_2$

Study habits

		S_1	S_2
A_1	M_1	31.4	23.6
	M_2	22.9	21.9
A_2	M_1	22.8	23.7
	M_2	19.3	15.6

Table 8-1(a) reveals that the highest and the lowest amongst the means of retention scores are 31.4 for good study habits-high previous attainment programmed instruction group and 15.6 for the group having poor study habits-low previous attainment and taught through conventional method. The general trend shown by the various means is that means belonging to programmed instruction groups are higher than the groups taught by conventional classroom methods.

In order to find out the effect of variables rigidity, study habits and methods of teaching on retention scores of students the method of analysis of variance with 2 x 2 x 2 factorial design was applied. The results obtained have been summarised in Table No. 8-2.

Table No. 8-3

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching rigidity and study habits.

Source of variation	Sum of squares	df	Mean square	F	Signi-ficance
Rigidity (R)	2.11	1	2.11	0.05	
Study habits (S)	127.51	1	127.51	3.07	
Methods of teaching (M)	812.81	1	812.81	19.57	*
R x S	25.32	1	25.32	.60	
R x M	56.12	1	56.12	1.35	
S x M	25.32	1	25.32	.60	
R x M x S	52.80	1	52.80	1.27	
Within cells	2990.70	72	41.53	-	

* Significant at .01 level

The analysis of variance has revealed F value of .05, 3.07 and 19.57 for the main effects of rigidity, study habits and methods of teaching respectively. Out of three main effects, two viz., for rigidity and study habits are insignificant. An exploration of the data (Cf Appendix E) shows that the means of retention scores for students with good and poor study habits are 23.32 and 22.80, the difference between the two being 2.52. In both the comparisons higher groups have retained better than the lower group, though the difference is statistically insignificant. The F value of 10.5 for the main effect of methods is significant at .01 level.

The means of retention scores of students taught by programmed and conventional methods are respectively 37.25 and 20.87. The programmed group has scored higher by 6.38 points than the conventional method group, programmed instruction leads to better retention than the conventional method.

The first order interaction effects:

The interaction effects of rigidity and study habits (R x S), rigidity and methods (R x M), and study habits and methods (S x M) on the retention scores of the students have emerged to be insignificant, the F value being .60, 1.35 and .60 respectively. This shows that the combined effect of rigidity - study habits, rigidity - methods of teaching and study habits - methods of teaching on the retention scores of the students is not meaningful statistically.

The second order interaction effect:

The combined effect of rigidity, methods of teaching and study habits on the retention scores of students is also insignificant, the F value being 1.27.

For investigating the effect of variables introversion, rigidity and methods of teaching on the retention scores of the subjects, the methods of analysis of variance with 2 x 2 x 2 factorial design was applied.

The results obtained have been presented in Table No. R-3.

Table No. R-3

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching, introversion and rigidity.

Source of variation	Sum of square	df	Mean square	F	Significance
Introversion (In)	158.7	1	158.7	4.65	**
Rigidity (R)	580.8	1	580.8	17.03	*
Methods of Teaching (M)	1442.13	1	1442.13	42.29	*
In x R	38.53	1	38.53	1.12	
In x M	.13	1	.13	-	
R x M	9.63	1	9.63	.28	
In x R x M	7.51	1	7.51	.22	
Within cells	3820.27	112	34.1	-	

* Significant at .01 level
** Significant at .05 level

Table No. R-3 indicates that the main effects of variables introversion, rigidity and methods of teaching on the retention scores of the students are significant, the F value being 4.65, 17.03 and 43.29.

The main effect of introversion is significant at .05 level showing thereby that the variable affects the retention scores of the student to some extent. The means of retention scores of high and low introversion are 25.2 and 22.9 respectively. This indicates that introverts retain better than extraverts.

The main effects of rigidity and methods of teaching on retention scores have emerged as highly significant i.e. beyond .01 level. The tabular F value for 112 degrees of freedom at .01 level of significance is 6.90. In comparison to this value, the obtained F values are more than two and half times for rigidity and seven times for programmed instruction. This establishes that these variables influences retention of students in mathematics to a very great extent. In order to determine the direction of these effects, means of retention scores for high and low rigids, programmed method and conventional method groups may be referred to. These are 26.3 and 21.85, 27.51 and 20.59 respectively. A comparison of the means indicates that the high rigid group, and students taught by programmed instruction are better retainers of learned material.

The first order interaction effects:

The effect on retention of interaction between (i) introversion and rigidity, (ii) introversion and methods of teaching, and (iii) rigidity and methods of teaching has emerged out to be insignificant showing thereby that those combinations do not affect retention of students in mathematics.

The second order interaction effect:

The combined effect of introversion, rigidity and methods of teaching on the retention scores of the students is insignificant.

In order to find out the effect of variables study habits, intelligence and methods of teaching on the retention scores of the students in mathematics, the method of analysis of variance with 2 x 2 x 2 factorial design was applied to the data. Three main effects, first and second order interaction effects were calculated and are presented in Table No. D-4.

Table No. R-4

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching, study habits, and intelligence.

Source of variation	Sum of squares	df	Mean square	F	Signi-ficance
Study habits (S)	252.05	1	252.05	6.32	**
Intelligence (I)	18.05	1	18.05	.45	
Methods of teaching (M)	1638.05	1	1639.05	41.08	*
S x I	24.2	1	24.2	0.6	
S x M	135.2	1	135.2	3.39	
I x M	57.8	1	57.8	1.44	
S x I x M	312.05	1	312.05	7.82	*
Within cells	2870.8	72	39.87	-	

* Significant at .01 level
** Significant at .05 level

The analysis of variance reveals that out of the three main effects two, namely, for study habits and methods of teaching have emerged out to be significant. The main effect of intelligence on the retention scores of the students is insignificant, F value being as low as 0.45. This shows that there exists no significant difference between the means of retention scores for high and low-intelligence students which are 24.12 and 23.17 respectively.

The F values for the main effects of study habits and methods of teaching are 6.32 and 41.08 respectively, the former being significant at .05 level and the latter at .01 level. The means of retention scores for students with good and poor study habits are 25.42 and 21.87, the former being higher than the later, showing good study habits have positive effect on the phenomenon of retention.

The means of retention scores of students taught by programmed and conventional methods are 23.17 and 19.12 respectively. The F value for this main effect, being 41.08, is almost seven times the required value for being significant at .01 level. This again establishes the superiority of programmed instruction over conventional methods so far as retention of students in mathematics is concerned.

The first order interaction effects:

In order to find out the combined effect on retention scores of the students, of (i) study habits and intelligence, (ii) study habits and methods of teaching, and (iii) intelligence and methods of teaching, the F values for each of the three combinations were calculated. All the three first order interactions have emerged out to be insignificant, showing thereby that these combinations do not influence the retention scores of the students.

The second order interaction effect:

The F value for the combined effect of intelligence, study habits and methods of teaching is 7.82, being significant at .01 level. This shows that variations in variables study habits, intelligence and methods of teaching bring subsequent changes in the retention scores. In order to examine the data minutely the means of retention scores for eight different combination of these variables have been presented in Table No. R-4(a).

Table No. R-4(a)

Showing means of retention scores of sub groups $S_1I_1M_1$, $S_1I_1M_2$, $S_1I_2M_1$, $S_1I_2M_2$, $S_2I_1M_1$, $S_2I_1M_2$, $S_2I_2M_1$ and $S_2I_2M_2$.

Study habits

Intelligence	Method	S_1	S_2
I_1	M_1	30.8	24.8
	M_2	22.1	18.8
I_2	M_1	26.5	30.6
	M_2	22.3	13.3

Table No. R-4(a) shows that students with good study habits, high intelligence and taught by programmed instruction have secured the highest mean of 30.8 whereas students with poor study habits, low intelligence and taught by conventional method have secured the lowest mean of retention scores, i.e. 13.3. In columnwise comparisons the combinations good study habits - programmed instruction - high intelligence, good study habits - conventional method - high intelligence and good study habits - low intelligence - conventional method have retained better than poor study habits - programmed instruction - high intelligence, poor study habits - conventional method - high intelligence and poor study habits - conventional methods - low intelligence groups respectively. But the combination poor study habits - programmed instruction - low intelligence have secured higher mean of retention scores 30.6 than good study habits - programmed instruction - low intelligence showing that students with poor study habits and low-intelligence retain better than student with good study habits, and low-intelligence when both are taught by programmed instruction. The examinations of means from the point of view of methods, in all the eight combinations, shows that the combinations with programmed method show higher means than the corresponding combinations with conventional method. This may be taken to indicate that students with any variation in study habits and intelligence retain better when taught through programmed instruction than those with corresponding variations and taught by conventional classroom methods.

For investigating the effect of rigidity, intelligence and methods of teaching on retention, each variable was classified at two levels as in the case of other analyses and the method of analysis of variance, with 2 x 2 x 2 factorial design, was applied. The results obtained have been summarised in Table R-5.

Table No. R-5

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching, rigidity and intelligence.

Source of variation	Sum of squares	df	Mean square	F	Signi-ficance
Rigidity (R)	86.11	1	86.11	1.91	
Intelligence (I)	15.31	1	15.31	0.34	
Methods of teaching (M)	632.81	1	632.81	14.05	*
R x I	27.62	1	27.62	.61	
R x M	70.32	1	70.32	1.56	
I x M	23.12	1	23.12	.51	
R x I x M	43.50	1	43.50	.96	
Within cells	3241.10	72	45.01	-	

* Significant at .01 level

From Table No. 8-5, it is clear that out of three main effects only one viz., that of method of teaching has emerged out to be significant. The F value for the main effects of rigidity and intelligence are as low as 1.91 and .34, indicating the fact that variations in those variables do not affect the retention scores of the students. The means of retention scores for high and low rigids are 25.57 and 23.50 respectively. The trend that high rigids, retain higher than low rigids is evident here as well, though in the result this difference is not statistically significant. The means of retention scores of high and low intelligent students are 24.97 and 24.10, which are almost equal showing thereby that intelligence does not influences retention to any sizable extent.

The F value for the main effect of methods of teaching on the retention scores of students is as high as 14.05, being significant beyond .01 level. This again establishes the fact that method of instruction affects the phenomenon of retention. The means of retention scores of students taught by programmed and conventional methods are 27.35 and 21.78 respectively the difference establishing the superiority of programmed instruction over conventional methods so far as retention scores are concerned.

The first order interaction effects:

The F values for the combined effect on (i) rigidity and intelligence, (ii) rigidity and methods of teaching, and (iii) intelligence and methods of teaching are .61, 1.56 and .81 respectively which are insignificant. This shows that variables rigidity and intelligence either combined together or each one of them being combined with any method of teaching produces no significant effect on the retention scores of the students.

The second order interaction effect:

The combined effect of variables rigidity, intelligence and methods of teaching on the retention scores of students is also insignificant, the F value being as low as .90. This shows that retention in mathematics is not influenced by any combination of the three variables.

In order to find out the effect of variables introversion, intelligence and methods of teaching on the retention scores of the subjects the method of analysis of variance, with 2 x 2 x 2 factorial design was applied. For this, introversion and intelligence were varied as high and low, and methods of teaching as programmed and conventional methods. The results of the analysis involving these variables have been summarised in Table No. R-6.

Table No. B-6

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching introversion and intelligence.

Source of variation	Sum of squares	df	Mean square	F	Signi-ficance
Introversion (In)	14.45	1	14.45	.47	
Intelligence (I)	48.05	1	48.05	1.59	
Methods of teaching (M)	1656.20	1	1656.20	54.93	*
In x I	48.05	1	48.05	1.59	
In x M	39.20	1	39.20	1.30	
I x M	.80	1	.80	-	
In x I x M	12.80	1	12.80	.42	
Within cells	2171	72	30.15	-	

* Significant at .01 level.

The analysis of variance reveals that out of three main effects, viz., those of introversion, intelligence and methods of teaching, only the last one is significant with an F value of 54.93. The main effect of methods of teaching on the retention scores of students is significant at .01 level. This shows that methods of teaching have a significant effect on the retention scores of students in mathematics. The means of retention scores of students taught by programmed instruction and conventional methods are 29.97 and 19.87 respectively making it evident that programmed instruction is superior to conventional method of instruction. The F value for the main effects of introversion and intelligence respectively are .47 and 1.59, which are statistically insignificant showing thereby that these variables do not have any relationship with the retention scores of the students. An examination of means of retention scores of students reveals that students with high and low introversion have means of 24.85 and 24 respectively, and the students with high and low intelligence score means of 25.2 and 23.65 respectively. The direction of the mean scores suggests that more introverted and more intelligent people retain higher than the extraverted and less intelligent students though the difference statistically insignificant.

The first order interaction effects:

For finding out the combined effect of variables (i) introversion and intelligence, (ii) introversion and methods of teaching, and (iii) intelligence and methods of teaching on the retention scores of students, F values for first order interaction between these pairs were obtained, which are 1.59, 1.30 and 0 respectively. These values are very low and insignificant showing that these combinations do not affect the retention scores of the students.

<u>The Second order interaction effects:</u>

The F value for the combined effects of variables introversion, intelligence and methods of teaching in various combinations on the retention scores of students is as low as .42, which is insignificant. This shows that the retention scores of the students learning mathematics do not vary with variations in introversion, intelligence scores and types of instructions.

For investigating the effect of variables rigidity (R), previous attainment in mathematics (A) and methods of teaching (M) on the retention scores of the subjects, the method of analysis of variance with 2 x 2 x 2 factorial design was applied. The analysis of the data has yielded three main effects, and first and second order interaction effects on the retention scores. The results obtained have been presented in Table No. B-7.

Table No. R-7

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching, rigidity and previous attainment.

Source of variation	Sum of squares	df	Mean square	F	Significance
Rigidity (R)	90.13	1	90.13	2.98	
Previous attainment (A)	1239.43	1	1238.43	41.03	*
Methods of teaching (M)	885.63	1	885.63	29.34	*
R x A	113.64	1	113.64	3.76	
R x M	5.04	1	5.04	0.18	
A x M	140.41	1	140.41	4.65	**
R x A x M	8.52	1	8.52	.23	
Within cells	3381.07	112	30.18	-	

* Significant at .01 level
** Significant at .05 level

Table No. R-7 indicates that out of the main effects of the variables rigidity, previous attainment in mathematics and methods of teaching, the last two have emerged out to be significant. The main effect of variable rigidity on the retention scores of the students is insignificant, the F value being as low as 2.98. The means of retention scores of the students having high and low rigidity are 24.6 and

22.86 respectively, again indicating that the high-rigid students have secured higher retention mean though insignificant than the low-rigid students.

The main effects of the variables previous attainment in mathematics and methods of teaching on the retention scores of the students are significant at .01 level, the F values being 41.03 and 20.34 respectively. This shows that the process of retention in mathematics is greatly affected by those variables. Further exploring the data, it has been found that the retention means of high and low previous attainment groups are 27.05 and 20.33 respectively. The comparison between these means show that high previous attainment have secured higher mean of retention scores than the lower group. This leads to the conclusion that those with high previous attainment in mathematics will retain subsequently learned material better than those with relatively low previous attainment.

The main effect of methods of teaching on the retention scores of the students has once again, emerged out to be significant. This, with the mean retention scores of programmed instruction and conventional method group being 26.45 and 21.01 respectively, establishes the superiority of programmed instruction over conventional methods of teaching so far as the retention scores of the students in mathematics are concerned.

The first order interaction effects:

The combined effects, on the retention scores of the students, of (i) rigidity and previous attainment, (ii) rigidity and methods of teaching, and (iii) previous attainment and methods of teaching were obtained by calculating F values for interactional effects of the above pairs of variables. The value for the first two being 3.70 and 0.18, are insignificant showing thereby that the combinations of the personality variable rigidity either with previous attainment or with methods of teaching produces insignificant effect on the retention scores of the learners.

The F value for the interactional effect of previous attainment in mathematics and methods of teaching being 4.65 is significant at .05 level. This has been represented graphically (Cf. Fig. C-5). This shows that a variation in previous attainment in mathematics with corresponding variation in the methods of teaching brings changes in the retention scores of the learners. For further exploring the data, the means of the different combinations of these variables have been presented in Table No. R-7(a).

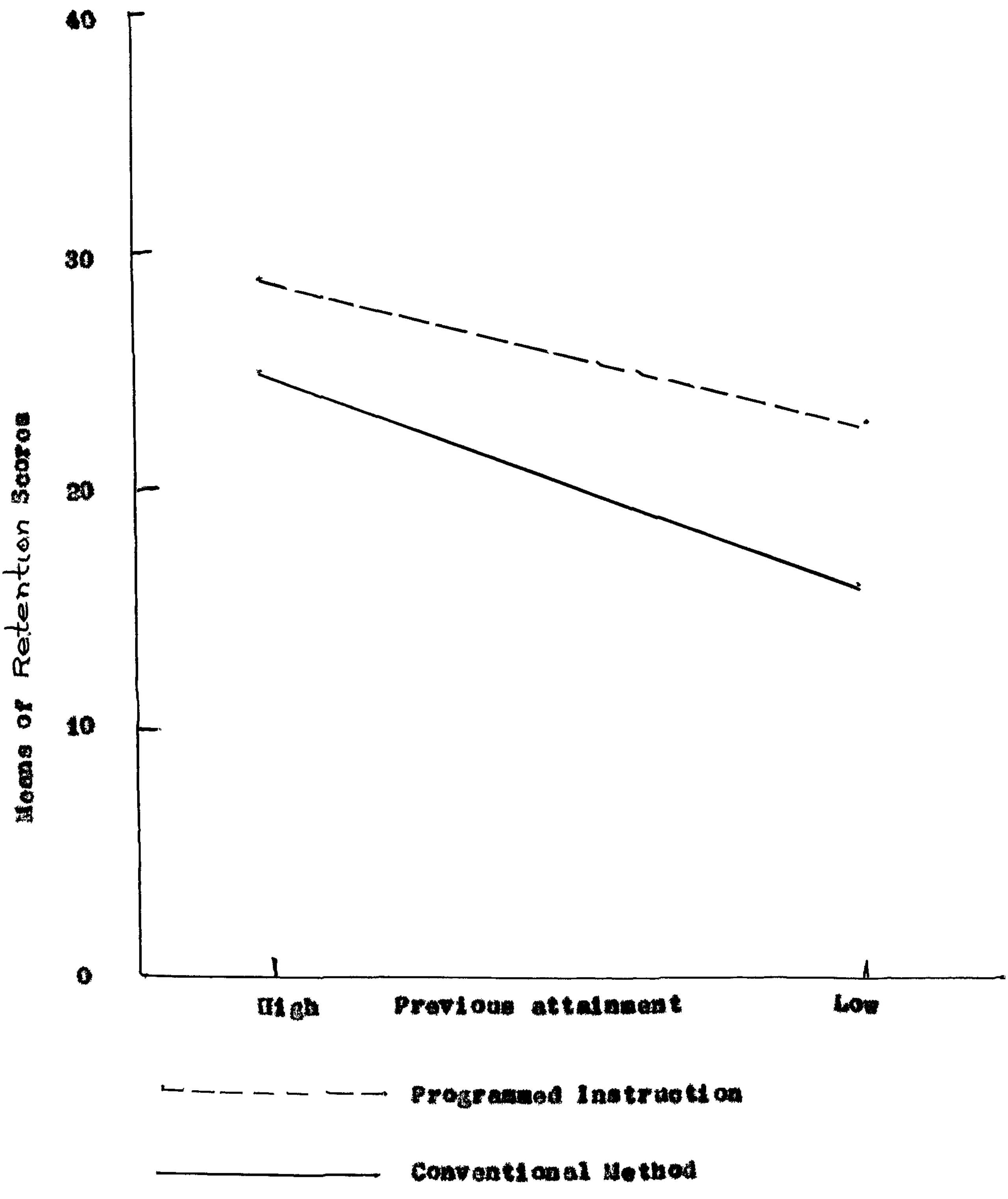


Figure 8-3. Representing interaction between Previous attainment and Methods of teaching.

Table No. II-7(a)

Showing means of retention scores of sub groups A_1M_1, A_1M_2, A_2M_1 and A_2M_2.

Methods of teaching		Previous achievement A_1	Previous achievement A_2
	M_1	20.06	23.8
	M_2	25.03	17.0

As evident from Table No. II-7(a) students with high or low previous attainment when taught through programmed instruction have obtained better mean retention scores than the students having similar previous attainment and taught by the conventional methods. The students with high previous attainment and taught by conventional method have secured a mean retention score as 25.03 in comparison with the students with low pre-attainment and taught by programmed instruction whose retention mean is 23.8. This shows that low previous attainment group when taught by programmed instruction retain lower than the students having high pre-attainment and taught by conventional methods.

The Second order interaction effect:

The F value for the combined effect of variables rigidity, previous attainment and methods of teaching on the retention scores of the students is 0.23, being insignificant and showing that combinations of these variables have no significant effect on the retention scores of the students learning mathematics.

For investigating the effects of variables introversion, previous attainment in mathematics and methods of teaching on the retention scores of the subjects, the method of analysis of variance with 2 x 2 x 2 factorial design was applied. The results have been presented in Table No. D-8.

Table No. D-8

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching, introversion and previous attainment.

Source of variation	Sum of squares	df	Mean square	F	Signi-ficance
Introversion (In)	20.0	1	20.0	0.58	
Previous attainment (A)	500.0	1	500.0	14.57	*
Methods of teaching (M)	2080.8	1	2080.8	60.66	*
In x A	6.05	1	6.05	.17	
In x M	2.45	1	2.45	.07	
A x M	84.05	1	84.05	2.45	
In x A x M	.20	1	.20	-	
Within cells	2470.00	72	34.30	-	

* Significant at .01 level.

The analysis of variance has yielded three main effects out of which two are significant. The F value for the main effect of introversion on the retention scores is 0.58, being insignificant showing thereby that variations in introversion scores do not bring any significant corresponding changes in the retention scores of the learners. The means of retention scores for students with high and low introversion scores are 24.32 and 23.32 respectively. Though high introverts retain more, as has also been shown earlier than the low introverts, the difference is insignificant.

The F values for the main effects of the variables previous attainment and methods of teaching on the retention scores respectively are 14.57 and 60.60, both being significant beyond .01 level. This shows that these variables affect retention. For further exploring the data, means of retention scores of students with high and low previous attainment, and taught by programmed and conventional methods were calculated separately. The students with high and low pre-attainment scores have secured retention means of 26.32 and 21.32 respectively, the former being higher than the latter. This shows that previous attainment does affect the phenomenon of retention in a positive direction.

The means of retention scores of the students taught by programmed and conventional method are 28.92 and 18.72

respectively showing that retention of programmed group is higher than that of students taught by conventional method. This establishes the superiority of programmed instruction over conventional classroom methods, so far retention of learned material is concerned.

The first order interaction effects:

The F values for the combined effects on the retention scores of (i) introversion and previous attainment, (ii) introversion and methods of teaching, and (iii) previous attainment and methods of teaching are .17, .07 and 3.45 respectively, all being insignificant. This shows that these combinations do not affect retention in mathematics.

The Second order interaction effect:

The combined effect of previous attainment in mathematics, introversion and methods of teaching on the retention scores of the students is insignificant, leading to the conclusion that combinations of these three variables do not affect significantly the retention scores.

The effects of variables introversion, study habits and methods of teaching on the retention scores of the subjects were, as in all cases, determined by the method of analysis of variance with 2 x 2 x 2 factorial design. The main effects and the first and second order interaction effects of these variables are presented in Table No. 8-9.

Table No. 8-9

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching, introversion and study habits.

Source of variation	Sum of squares	df	Mean square	F	Signi-ficance
Introversion (In)	344.45	1	344.45	9.5	*
Study habits (S)	703.05	1	703.05	19.33	*
Methods of teaching (M)	273.80	1	273.80	7.55	*
In x S	2.45	1	2.45	.06	
In x M	45.00	1	45.00	1.24	
S x M	145.80	1	145.80	4.02	**
In x S x M	304.20	1	304.20	8.39	*
Within cells	2610.20	72	36.25	-	

* Significant at .01 level
** Significant at .05 level

Table No. 8-9 reveals that the main effect of the variables introversion, study habits and methods of teaching on the retention scores of the students are significant. The F value for the main effect of introversion is as high as 9.5, being significant beyond .01 level. This shows that an average variation in introversion scores changes the retention scores. The means of retention scores of high and low introversion students are 26.35 and 22.2 respectively, the former mean being higher than the latter one. This, as also all other analyses of introversion, indicates that introversion scores and retention scores of the students are positively related, high introverts retaining higher than low introverts.

The F value for the main effect of study habits of the students on the retention scores is 19.53. This values is three times the required value for being significant at .01 level which indicates that study habits of students influence their retention scores. The means retention scores for students with good and poor study habits are 27.25 and 21.3, the former mean being higher by 5.9 points than the latter one. This establishes that the students with good study habits retain better than those having poor study habits.

The F value for the main effect of methods of teaching on the retention scores of the students is 7.55, also being significant beyond .01 level. Here, again methods of instruction are shown to affect the phenomenon of retention. The means of retention scores of the students taught by the programmed and conventional methods of instruction are 26.12

and 22.42 respectively, the latter mean being lower than the former. This establishes the fact that students learning mathematics with programmed instruction retain better than those taught by conventional methods.

The first order interaction effects:

For finding out the combined effect of (i) introversion and study habits, (ii) introversion and methods of teaching, and (iii) study habits and methods of teaching on the retention scores of the students, the F values for all these interactions were calculated. The interaction effects of the personality variable introversion with study habits as well as with the methods of teaching have emerged out as insignificant, the F value being as low as .06 and 1.24 respectively. This indicates the fact that combination of personality variable introversion either with study habits or with methods of teaching produces insignificant effect on retention scores.

The F value for the combined effect of study habits and methods of teaching on the retention scores of the students is 4.02, being significant at .05 level (Cf. Figure C-6). This indicates that the retention scores of the students are affected with the different combinations of study habits and methods of teaching. In order to explore the data further

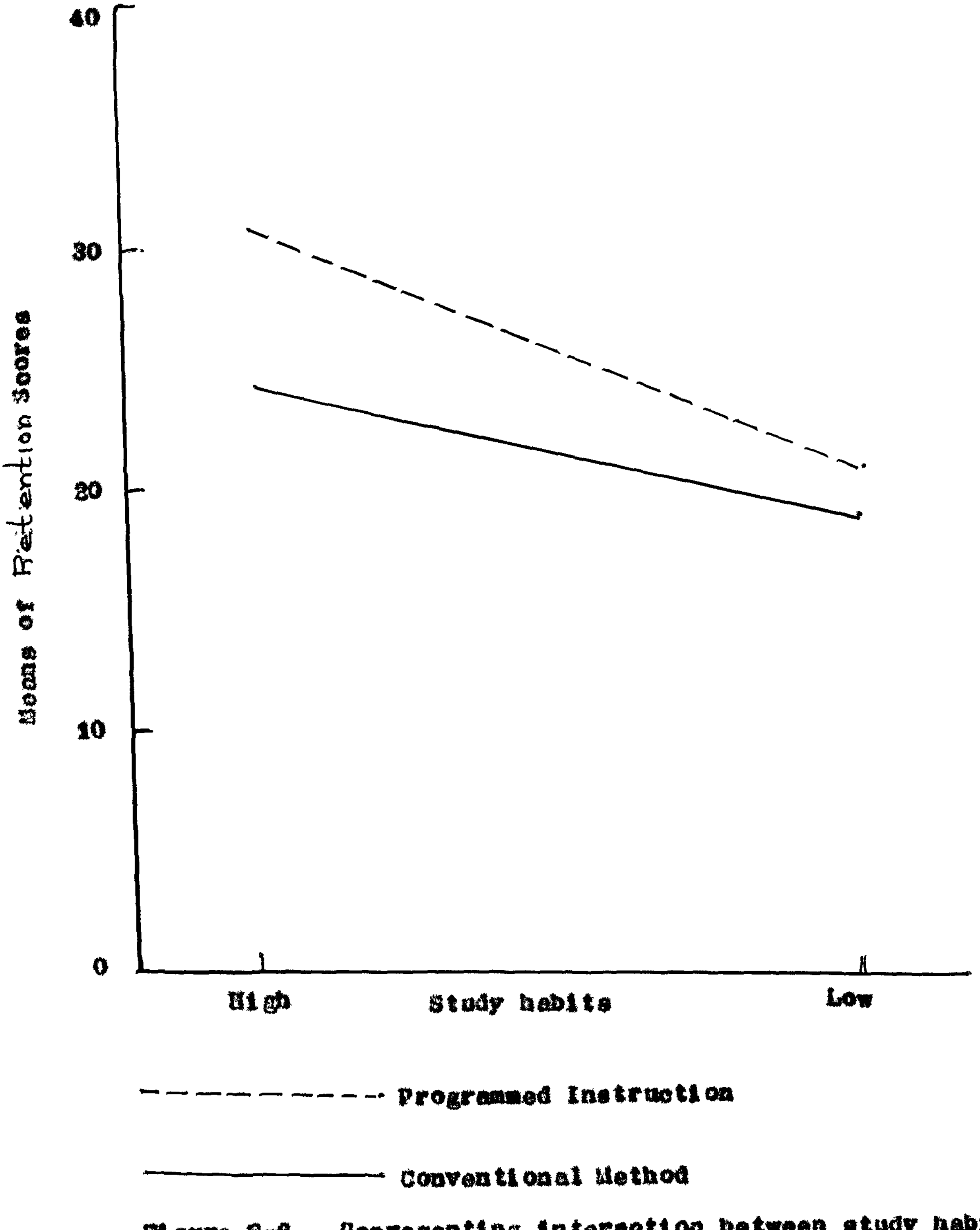


Figure E-6. Representing interaction between study habits and Methods of teaching.

the means of retention scores of the four possible combinations were calculated and are presented in Table No. 8-9(a).

Table No. 8-9(a)

Showing means of retention scores of students belonging to sub groups S_1M_1, S_1M_2, S_2M_1 and S_2M_2.

Methods of teaching		Study habits S_1	Study habits S_2
	M_1	30.45	21.8
	M_2	24.05	20.8

Table No. 8-9(1) reveals that the highest mean of retention scores is 30.45 which belongs to good study habits - programmed method group. In comparison to this the lowest mean of retention scores is 20.8 belonging to conventional method - poor study habit group. When comparisons are made for methods, the means of programmed instruction groups have been found superior to conventional method groups with similar study habits. The students with good study habits have been greatly benefitted by the programmed instruction than the conventional method as the difference between these two means is as high as 6.4. Thus the means of all the four combinations of study habits and methods of teaching indicates that variations in study habits with corresponding changes in methods of instruction produces significant changes in the retention scores of the students.

<u>The second order interaction effect:</u>

The F value for the combined effect of variables introversion, study habits and methods of teaching on the retention scores of the students is 8.39, being significant beyond .01 level. This shows that the combined effect of these variables influences the phenomenon of retention. In order to explore the data further means of retention scores of the students with different combinations of variables introversion, study habits and methods of teaching were calculated and are shown in Table No. 8-9(b).

Table No. 8-9(b)

Showing means of retention scores of students belonging to sub groups $In_1M_1S_1$, $In_1M_2S_1$, $In_1M_1S_2$, $In_1M_2S_2$, $In_2S_1M_1$, $In_2S_1M_2$, $In_2M_1S_2$ and $In_2M_2S_2$.

Introversion

Study habits		Methods of teaching	In_1	In_2
	S_1	M_1	31.5	29.4
		M_2	27.5	20.6
	S_2	M_1	26.4	17.2
		M_2	20.0	21.6

As indicated by Table No. R-9(b) the highest of retention means being 31.5 belongs to high introversion good study habits programmed instruction group whereas the lowest mean of 17.2 belongs to low-introversion poor study habits - programmed method group. The columnwise comparisons indicate that high introversion-poor study habits - conventional method group and low introversion-good study habits - conventional method group students have secured almost equal means (20 and 20.6 respectively) of retention scores.

For finding out the effects of variables previous attainment, intelligence and methods of teaching on the retention scores of the students, the method of analysis of variance with 2 x 2 x 2 factorial design was applied. For this, as in all other cases variables previous attainment and intelligence were varied as high and low, and methods of instruction as programmed and conventional method. The main effects of these variables and first and second order interaction effects have been presented in Table No. R-10.

Table No. 8-10

Summary of analysis of variance of retention scores of students classified on the basis of method of teaching previous attainment and intelligence.

Source of variation	Sum of squares	df	Mean square	F	Signi-ficance
Previous attainment (A)	938.45	1	938.45	31.09	*
Intelligence (I)	.20	1	.20	.00	
Methods of teaching (M)	1248.20	1	1248.20	41.35	*
A x I	96.8	1	96.8	3.20	
A x M	3.2	1	3.2	.10	
I x M	11.25	1	11.25	.37	
A x I x M	110.45	1	110.45	3.65	
Within cells	2172.96	72	30.18	-	

* Significant at .01 level

As is revealed by Table No. 8-10, F values for the main effects of variables previous attainment, intelligence and methods of teaching on the retention scores of the students are 31.09,0 and 41.35 respectively. Out of these three effects, the main effect of intelligence has emerged out to be insignificant indicating, as all other analyses involving intelligence do, that intelligence of students does not affect their retention scores.

The main effects of previous attainment and methods of teaching on retention scores are significant beyond .01 level. This indicates that these variables affect the phenomenon of retention in mathematics to a considerable extent. The means of retention scores of students with high and low previous attainment are 29.10 and 22.25 respectively the former mean being higher than the latter. The means of retention scores for students taught by programmed and conventional methods are 29.62 and 21.72 respectively. The retention mean for programmed group being higher by 8.1 points than the retention mean for the conventional method group. This again establishes superiority of programmed instruction over the conventional methods of teaching as far as retention is concerned.

<u>The first order interaction effects:</u>

The F values for the combined effect of (i) previous attainment and intelligence, (ii) previous attainment and methods of teaching, and (iii) intelligence and methods of teaching on the retention scores of the students are 3.2, .10 and .37 respectively. All the three values are insignificant meaning thereby that these combinations do not affect retention scores of the students.

The second order interaction effect:

The combined effect of previous attainment in mathematics, intelligence and methods of teaching on the retention scores of the students is insignificant, F value being 3.65.

CHAPTER - VII

SUMMARY AND CONCLUSIONS

The present study has been mainly concerned with a comparison of two approaches to teaching, namely, programmed instruction and the conventional classroom method. As learning refers to the learner, some reference to learner characteristics was inevitable. Hence the learning outcomes through the two methods were analysed in the context of certain learners characteristics.

Achievement through programmed instruction has been a matter of controversy amongst psychologists and educationists. Starting with Little (1934) there have been a number of studies comparing classroom teaching with automatic teaching method or programmed instruction.

Research activities in the field of programmed instruction gathered momentum with the publication of Skinner's two papers "The science of learning and art of teaching" and "Why we need teaching machines" in 1954 and 1958 respectively. An unprecedented number of such comparative studies in an attempt to establish the effectiveness of programmed instruction was undertaken prefering different claims about the method. It was more or less established by these studies that students learn better with programmed instruction than with the conventional method.

Doubts were, however, raised regarding the effectiveness of programmed instruction for all personality types of students (Fry, 1963). The 1960's, thus saw a change in the research trends in programmed instruction. Instead of verifying the effectiveness of programmed instruction, these researches tried to explore the possible relationship between personality, i.e. psychological factors, and achievement through programmed instruction. Amongst such studies, those conducted by Shay (1961), Silberman (1961) Reed and Hayman (1962), Lambert, Miller and Wiley (1962), Thomas (1970), Kapadia (1972), Sanswal (1978) and Patel (1978) deserve special mention. These studies found achievement through programmed instruction to be also a function of learner's characteristics like intelligence, anxiety, creativity, study habits, introversion-extraversion, need achievement etc.

There were equally good number of researches done, for example, by Glaser and Reynold (1962), Feldhusen and Eigen (1963), Desai (1966), Nagar (1971) and Govinda (1976), which made claims that programmed instruction minimised the gap between achievement levels of groups high and low in characteristics which were understood to be determinants of learning.

A review of such studies has indicated that the relationship between learners personality and his achievement through different methods of instruction may be more complex than has been generally recognised.

In the context of the above, it was thought worthwhile to conduct this study with the following objectives:

(a) To compare the outcomes of learning mathematics through the method of programmed instruction and conventional method.

(b) To find out whether intelligence of students is differentially related to their achievement and retention when they learn mathematics through the aforesaid two methods.

(c) To ascertain whether achievement and retention through programmed instruction or conventional method are related to introversion-extraversion, and, if so, in what manner.

(d) To determine whether the achievement and retention scores of students learning instruction or conventional method are influenced by variable rigidity-flexibility.

(e) To find out whether study habits of students have any differential relationship with achievement and retention when taught by programmed instruction or conventional method.

(f) To determine whether previous attainment of students has any differential relationship with their achievement and retention scores when taught by either of the aforesaid two methods.

The topic selected for teaching students was "Set Theory" from modern mathematics. Since no good programme was available the author himself developed it for the present population.

The subject matter to be taught to the students was analysed and arranged logically. The first draft was written and initially tried out with average, below average, and above average students. It was reviewed and edited in the light of the responses made and the errors committed by the students and was, again, tried out on a group of 30 students. The programme was then finalised and made ready for use (Cf. Supplement attached to the thesis).

As discussed earlier, the conventional method was not left undefined. The content to be taught was arranged logically for classroom teaching in the manner as was done in programmed instruction. A plan for presenting the subject matter to the students was chalked out after a discussion with teachers who participated in the present experiment. It was commonly agreed to follow Herbartian steps with Heuristic approach. The learning environment was made effective by involving pupil teacher activities like forming "Sets" of articles available in the classrooms, solving problems with the help of students etc. and by using daily experiences of students in the teaching of the subject matter.

The present investigation was conducted on a sample of 378 students taken from 12 sections of IX Class from eight different higher secondary schools in Jaipur city. This total sample was divided into two equal groups of 189 students each. One, the experimental group, was taught through programmed instruction and the other, the control group, by the conventional method of teaching. It was ascertained that the two groups did not differ much in factors like age, socio-economic status and locality of habitat.

As mentioned elsewhere, the present study included intelligence, rigidity, introversion, study habits, and previous achievement in mathematics as variables. Since standardised tests for all, except previous achievement in mathematics, were available, these were utilised in the study. For measuring intelligence, rigidity, introversion and study habits of the students the tests used were respectively, Jalota's General Mental Ability Test (1964), Hindi version of Gaugh-Sanford Rigidity Scale (Ali, Misar, 1975), Hindi version of Maudsley Personality Inventory (Jalota and Kapoor, 1965) and Rastogi's Study Habit Inventory (1966). The tests for previous attainment in mathematics, post test of achievement, and delayed test of achievement were developed by the investigator himself.

There were two conditions of the experiment, viz., programmed instruction and conventional method. In programmed instruction programmed lesson booklets on Set Theory were given to the 189 experimental group students divided into six sub-groups of convenient sizes for self learning in regular class periods on six consecutive days. The control groups, also six in number and of similar sizes, were taught by the respective subject teachers without disturbing the natural setting of the school - the teachers having agreed upon the daily plan of teaching.

At the conclusion of teaching, i.e. on the sixth day, both experimental and control groups were given a post-test of achievement. After the expiry of two months a delayed test of achievement was given to the students for measuring retention in mathematics.

The data thus collected were dichotomised in order to draw sub-groups of subjects high and low on the basis of variables intelligence, rigidity, introversion, study habits and previous achievement in mathematics. For this, students falling on 60th percentile and above were kept in "high" and those falling on 40th percentile and below in "low" sub groups on each of the five variables.

Due to reasons discussed earlier only three variables were analysed at a time and a 2 x 2 x 2 factorial design was used for the analysis of variance applied to the data. Method of teaching, being the main independent variable of the study, was taken for analysis along with two of the other variables at a time. Also, since the effect on achievement of the personality characteristics and the other antecedent variables irrespective of the method of instruction employed was of little interest to the study, only those combinations which included methods of teaching as one of the variables were taken up for analysis. Thus ten analyses were made of the achievement scores and ten of the retention scores.

The results have been presented in two parts, part one summarising the effect of all the five independent variables on achievement through programmed instruction and conventional method, and part two being concerned with the manner in which retention scores are affected by independent variables.

Reviewing the analysis of variance tables C-1 to C-10 in which analysis of achievement scores has been done, it is noted that in all cases the main effect of method of teaching is significant. Also, the mean of achievement scores for programmed instruction group (M_1) is in each case higher than that for the conventional group (M_2). The differences between means being quite large and F values being significant at .01

level in all analyses it is shown that achievement in mathematics through programmed instruction is higher than through conventional method.

From amongst the five learner variables included in the study introversion appears in Table Nos. C-3, C-6, C-8 and C-9. Out of the four main effects of introversion, three are found to be significant at .01 level, the means of achievement scores for high introverts being higher than those for extraverts in all the analyses. This confirms earlier findings that introverts are better learners than extraverts.

The first order interactions of introversion and methods of teaching in all the four analyses were found to be insignificant. This shows that introversion along with any one of the methods does not have any differential effect on achievement scores of the students. The results corroborate the findings of most of the earlier studies which show no differential effect of introversion when combined with any of the methods.

Rigidity, the second personality factor included in the present study, has been analysed in the Tables C-2, C-3, C-5 and C-7. The main effect of this variable was found to be insignificant in all the four analyses. This indicates the fact that students achieve high or low in mathematics irrespective of their being rigid or flexible. There is, however, one clear trend in the direction of mean differences namely, that in almost all the cases the rigids are higher in mean achievement than the flexibles - the difference being in the expected direction when seen in the context of earlier studies. This trend, however, does not show up sufficiently for the results to be statistically significant.

The first order interactions of rigidity-flexibility and methods of teaching appear four times, out of which two are found significant-flexibles with programmed instruction scoring the highest and with conventional method the lowest. This shows that rigidity-flexibility dimension combined with different methods of teaching has differential effect on the achievement scores of students.

Intelligence is another variable whose main effect on achievement has been found to be significant in all the analyses involving it - Cf. Tables C-4, C-5, C-6 and C-10. This result is also in agreement with the generally accepted findings that intelligence is the best predictor of achievement at high school and comparable levels.

The first order interactions between methods of teaching and intelligence which have appeared four times in the present analysis are all the time insignificant. This finding, again, is in the expected direction showing that intelligence is an important force in achievement and variation in method does not make any difference in the effect of this variable.

The analysis of the effect of study habits on achievement of learners learning mathematics through programmed instruction and conventional method of teaching are presented in Table Nos. C-1, C-2, C-4 and C-9. Out of four main effects, only one turns out to be significant. This shows that study habits do not in general affect the achievement scores. It is, however, interesting to note that the main effect of study habits emerges out to be significant in the analysis where study habits are analysed along with introversion-extraversion. In this case, as may be expected, students with good study habits achieve higher than those with poor study habits.

Among the four first order interactions of study habits and methods of teaching only one happens to be significant. Thus it is shown that study habits of the learners generally do not affect their achievement scores differentially when combined with either of the two methods. In one case where they do interact with methods of instruction, the highest achievement is surprisingly shown by those students who are taught by programmed instruction and have poor study habits, followed by those who have been taught by programmed instruction and have good study habits. This result of the analysis in question is explainable only in terms of the dominating effect of programmed instruction, the influence of study habits being negligible.

The effect of previous achievement has been presented in Tables C-1, C-7, C-8 and C-10. The main effect of previous achievement has been found significant at .01 level in all the four analyses involving this variable. Reviewing the achievement means of high and low previous attainers, it is seen that the former have achieved higher than the latter, Previous achievement, thus has been found to affect substantially the achievement of students, a result which will be expected in any study of learning outcome. Knowledge builds up on the basis of previous knowledge and any one who has learned something well previously will gain better subsequently than one who has not done so well.

Out of four first order interactions between previous achievement and methods of teaching, only one has emerged out to be significant. This happens when previous achievement is analysed in combination with rigidity and methods of instruction. The students, in this case, having high previous achievement and taught by programmed instruction score higher than those with poor previous achievement and taught by conventional method. This is as would be, obviously, expected.

The other three analyses have revealed that previous attainment and methods of teaching, though affecting achievement independently do not have any differential effect when combined with each other.

The second order interaction effects are also studied in all the ten analyses. Out of ten second order interactions effects thus obtained, only two, namely, study habit x introversion x method, and previous achievement x intelligence x method are found significant. (Table No. C-9(a) and C-10(a) respectively). This shows that study habits when combined with introversion and methods of teaching significantly affect the level of achievement of students learning mathematics.

A perusal of means shows that introversion with good study habits when combined with programmed instruction leads to better achievement than extraversion with poor study habits combined with conventional method. Further, highly intelligent students with high previous achievement when taught by programmed instruction, achieve better than students poor in intelligence with poor previous achievement and taught by conventional classroom method.

As discussed earlier the retention scores of students were also analysed and the results presented in Table Nos. R-1 to R-10. As in the case of achievement scores, the means of retention scores of programmed instruction group were found to be higher than the conventional teaching group in all the ten analyses. This shows that programmed instruction helps not only in better achievement but also in better retention in mathematics as compared to the conventional method.

The main effect of introversion on retention scores of the students has been found significant twice out of the four analyses. The means of retention scores for introvert students are, however, found to be higher than extraverts in all the four analyses. This shows that introverts, not only achieve better than extraverts but also retain better.

The first order interaction effects of introversion and methods of teaching worked out four times, as shown in Tables R-3, R-6, R-8 and R-9, are insignificant. Though introversion and methods affect the levels of retention independently, the first order interaction of these variables reveal no combined effect on the retention scores of the students.

As regards intelligence which has been analysed four times along with other variables for finding out its effect on retention scores in mathematics, interesting results have come to light. None of the four main effects of intelligence has emerged out to be significant. Thus intelligence, which is generally regarded as the best predictor of achievement, is found to have no effect on retention of the material learnt.

As the first order interactions between intelligence and methods have been found insignificant, it is clear that these two variables do not have a combined effect on retention.

The main effect of study habits which have appeared in Tables R-1, R-2, R-4 and R-9, has been found significant in 3 out of four analyses. The means of retention scores of subjects having good study habits are higher than those having poor study habits. This shows that study habits are helpful in retention of mathematics although not so effective in the learning of the subject as revealed by the analysis of achievement scores.

The first order interaction between study habits and methods of teaching, which appears four times, is significant in one case only. Though programmed instruction and good study habits help in better retention independently, their combined effect on retention is almost negligible.

Rigidity, analysed in Tables R-2, R-3, R-5, and R-7 has only one main effect significant out of four. This shows that rigidity does not affect retention scores to any large extent. In the one case where rigidity does affect retention scores of students significantly, the mean retention score for rigids is higher than that for flexible students.

The first order interaction effects of rigidity and methods of teaching have emerged out to be insignificant, meaning thereby that retention scores are independent of the combined effect of these two variables.

The effect of previous achievement on retention has been presented in Tables R-1, R-7, R-8 and R-10. All the main effects of this variable are found to be significant at .01 level. This shows that previous achievement in mathematics not only influences achievement scores of the subjects, as revealed by the analyses of achievement scores, but also affects retention scores. In all the four comparisons, students with high previous attainment have secured higher retention means than those having low previous achievement.

Out of four interaction effects of previous achievement and methods, only one happens to be significant. This shows that these two variables have little combined effect on retention. In the one case where interaction effect is significant, it is in favour of high previous achievement combined with programmed instruction.

The second order interaction is worked out ten times with method and two of the remaining five independent variables appearing each time. Out of these only three interaction effects, viz., study habits x previous achievement x methods, introversion x study habits x methods and intelligence x study habits x methods, have emerged out to be significant.

Out of the three significant interaction effects that of variables study habits, previous achievement and methods, presented in Table B-1(a), happens to be significant at .01 level. A perusal of the mean scores shows that students with good study habits and high previous achievement when taught through programmed instruction retain better than those who have poor study habits and low previous achievement, and have been taught by a teacher in the conventional manner.

As shown by Table B-4(a) the second order interaction effect of intelligence, study habits and methods of teaching is also significant at .01 level. The mean scores indicate that high intelligence combined with good study habits and programmed instruction leads to better retention.

The effect of second order interaction amongst variables introversion, study habits and methods of teaching also found to be significant at .01 level shows that introvert students with good study habits when taught by programmed instruction retain better than extravert students who have poor study habits and are taught by a teacher in the conventional manner.

The results of the study as summarised in the present chapter, lead to the following conclusions:

1. Programmed instruction is a superior and far more effective method and leads to better achievement than conventional classroom teaching.

2. Programmed instruction is a better method not only in relation to achievement but also in relation to retention.

3. The personality dimension of introversion-extraversion has highly significant effect on achievement and some on retention scores of students, introverts being superior to extraverts.

4. Introversion-extraversion when combined with any of the methods has little differential effect on achievement or retention; but introverts with poor study habits achieve better than extraverts with poor study habits when both are taught through programmed instruction.

5. Intelligence has highly significant effect on achievement, more intelligent students achieving higher than less intelligent students.

6. Intelligence, however, does not exert any influence on retention of the learned material.

7. Intelligence even when combined with one or the other of the two methods of teaching does not show any effect on achievement or retention of the learners.

8. Students with good study habits retain better than those having poor study habits. This effect, however, does not show up so far as achievement is concerned.

9. The personality variable rigidity affects neither achievement nor retention of students.

10. When rigids and flexibles both are taught through programmed instruction, flexibles achieve higher than rigids. This trend is reversed when teaching happens to be through conventional method.

11. The variable rigidity when combined with methods of teaching does not have any differential effect on retention scores of the students.

12. Previous achievement in mathematics significantly affects achievement and retention scores of the students. The students with high previous attainment achieve and retain higher than those who have poor previous achievement.

13. The combined effect of previous achievement in mathematics and method of teaching is insignificant on achievement and retention of the learners.

14. Students poor in previous achievement when taught by programmed instruction achieve better than high achievers taught by conventional method.

CHAPTER - VIII

DISCUSSION OF RESULTS

The present chapter aims at discussion, interpretation and, wherever possible, generalisation of results arrived at by this study. This is attempted in the light of theoretical formulations and results and interpretations offered by previous studies in related fields.

It may be recalled that the present study has attempted to compare the learning outcomes of students learning mathematics through programmed instruction and conventional method of teaching. In doing so it has, firstly, attempted to find out whether programmed instruction is such a powerful method of instruction that it either significantly enhances or reduces the difference in the achievement of students varying in intelligence, introversion, previous achievement in mathematics, rigidity and study habits, in comparison to their achievement when exposed to conventional method.

The present study has revealed that achievement of students learning mathematics through programmed instruction is better than those who are taught by teachers through the usual methods of classroom instruction. This result is in confirmity with the earlier researches showing the superiority of programmed instruction over conventional method of teaching. The high achievement of the programmed instruction group may be due to the two psychological principles involved, viz., individual pacing and reinforcement.

Individualised pace of learning is an important factor. It is found by Pollettle (1961) and Maccoby and Sheffield (1958) to contribute to better learning. Programmed instruction gives adequate opportunity to each learner to study and comprehend every learning step at his own rate of learning which in turn gives psychological satisfaction to the individual. On the other hand, in conventional method, where the teacher proceeds with an average speed, slow learners are dragged whereas fast learners have to wait for the next learning step. This may have depressing affect on the performance of each group though due to different reasons.

Reinforcement, another major psychological principle of learning finds its suitable application in programmed instruction. Research evidences mustered by Angell (1949), Michael and Maccoby (1953) and Meyer (1960) show that immediate knowledge of results contributes to better learning. As programmed instruction makes provision for reinforcement in the form of immediate knowledge of results at each and every learning step, it is bound to lead to better learning than conventional teaching in which no such reinforcement is provided as a rule.

As for the answer to a part of the question whether programmed instruction is such a powerful method of instruction that it either enhances or reduces the difference in achievement of high and low intelligent pupils in comparison to their achievement through conventional methods, statistically the interaction between intelligence and method of instruction was insignificant. In order to further probe this question comparisons between achievement of brilliant students taught by conventional method and low intelligent students taught by programmed instruction were made. It is interesting to note that students with low intelligence and taught by programmed instruction achieved significantly higher than brilliant students taught by conventional method. This shows the extent to which programmed instruction is effective as a method. This may be explained by the fact that lower-ability students are greatly helped by immediate knowledge of results provided by programmed instruction. This sustains their interest and efforts and provides positive reinforcement. Further, as discussed earlier, programmed instruction, by virtue of being more analytical, logical and individualised method, and engaging the learner more actively in the task, aids the mental processes involved in learning while the usual classroom method is not capable of doing so. This difference between the methods affects learning to the extent that even the bright students are surpassed in learning by the relatively less bright students if the former are taught through the conventional method and the latter through programmed instruction.

The present study also reveals that introverts achieve higher than extraverts. This, as hypothesised earlier is confirmatory of earlier research findings and is in line with the theoretically understood relationship between introversion and the learning process. There appears to be no relationship between introversion-extraversion and methods of teaching. Introverts learn higher irrespective of the method they are taught with. On the other hand programmed instruction leads to better achievement than the conventional method in the case of both introverts and extraverts. The expectation of a differential effect on achievement of introversion when combined with programmed instruction has not been confirmed.

The expectation was based on Eysenck's theory that the process of excitation would be quick and that of inhibition weak in the case of introverts (Eysenck and Eysenck, 1969). It was expected that programmed instruction, being based on conditioning principles, would take better advantage of the process of excitation than the conventional method and thus enhance the learning process of introverts. The present results, however, point to the conclusion that extraverts, who are not easily excited in ordinary teaching situations may be stimulated by programmed instruction to the extent that the expected trend of enhanced difference of achievement between these two types when taught by programmed instruction would not emerge.

Previous achievement in a subject, as universally expected, is shown by the present study to affect the learning outcomes of students. As regards the differential effect of previous achievement on achievement through programmed instruction and conventional method, the present study does not yield any significant results. These findings, therefore, at best confirm the positive effect of previous achievement on subsequent achievement and at the same time affirm that method and previous achievement play their role independently of each other.

One interesting result, however, that has emerged out from the analyses is that students poor in previous achievement when taught by programmed instruction have scored significantly better than high previous achievers taught by conventional method. This reflects the fact that programmed instruction by virtue of its being individualised instruction and providing much needed immediate reinforcement raises the achievement level of students who have been poor achievers, so much so that they achieve even higher than those who were better students when both the groups were taught by the conventional method.

The variable of rigidity-flexibility has no direct effect on achievement. The effect of rigidity-flexibility is, however, pointed up in interaction with the method of teaching. The flexibles, when taught by programmed instruction achieve higher than rigids taught by the same method. This trend of achievement is reversed when the method of teaching is conventional.

The superior achievement of flexibles through programmed instruction, it may be argued, is due to the fact that such persons are ready to adapt themselves in new learning situations whereas rigids, who are averse to change, find themselves ill at ease while learning through a new method like programmed instruction. Besides, rigid persons are dependence-prone and willing to follow a definite line given by an external authority, namely the teacher, whereas flexibles go about more easily in situations changing from one place to another even in the same lesson.

Contrary to expectation, the variable "Study habits" showed no significant effect on achievement. The only explanation that can be offered for this negative finding is that programmed instruction being a powerful method of instruction offsets the effect of study habits. It might have helped students with poor study habits to such an extent that the difference between the achievement of the two groups has been mitigated. As students with poor study habits lack in analysing, synthesising and comprehending the subject matter in a systematic way, they require proper guidance for learning the subject matter. The systematically and logically arranged steps of programmed instruction provide them such an aid and lead them to achieve high, sometimes even higher than their counterparts with good study habits but taught by conventional method (Cf. Appendix D).

As for retention this study shows that students who learnt mathematics with programmed instruction retained better than those who were taught by conventional method. Since achievement differences of these two groups have also been found to be significant it may be presumed that loss of learned information and skill was commensurate with the principle of "better learning lesser forgetting". These findings are in the expected direction and corroborate the research findings of Desai (1966) and Sharma (1968) who also found that students taught by programmed instruction retained better than those taught by conventional method.

The superiority in retention of programmed instruction group over conventional method group may be attributed to the motivational effect of programmed instruction on the learner. Nutting and Greewald (1968) have pointed out that "subjects' motivational orientation is responsible not only for the fact that certain $S_1R_1-S_2$ sequences are selectively perceived and acquired, but also for superior perseveration of those expectations and skills that play a role in the projects and tasks at which the subject is performing"(P.127). Also, Thorndike and Hull have emphasised that superiority in retention is a function of reward or need reduction which, as discussed earlier, is amply provided by programmed instruction.

This study also shows the effect of intelligence on retention to be insignificant, although the effect of intelligence on learning as revealed by achievement scores, was found to be highly significant. The conclusion is very obvious, that is that intelligence does not so much aid the process of assimilation and perseveration essential to retention. Programmed instruction on the other hand, helps in those processes, to such an extent that the difference between high and low intelligence groups which shows up in learning is reduced to being insignificant. Thus the present study reveals that the method of programmed instruction reduces the gap between high and low intelligence students, as far as retention is concerned.

A further comparison of scores of low intelligence students who were taught by programmed instruction with scores of high intelligence students taught by conventional method reveals the interesting fact that the former retain significantly higher than the latter. This, it may be argued, happens on account of the positive effect of programmed instruction cutting across the effect of intelligence. This could be expected in relation to retention where intelligence is almost ineffective. It would be interesting to recall in this connection that even in the case of initial achievement, where intelligence is highly effective, a difference in favour of low intelligence group taught by programmed instruction is found when compared with high intelligence group taught by conventional method.

In view of intelligence being ineffective in retention, it is not surprising at all that introversion-extraversion variable plays no unequivocal part in this process. As explained in the case of intelligence, here also introverts are better in initial learning process. In their case excitation is quick and intensive, while inhibition is weak and slow. In case of extraverts, on the other hand, the intensity and preponderance of the excitation inhibition process is reversed. An explanation may be proposed in terms of the same characteristics as lead the introvert to better achievement. The excitation caused by, and hence better learning of, the intervening activities by the introvert may cause retroactive inhibition to set in and, thus, reduce the difference between him and the extravert as far as the retention of previously learned material is concerned.

The positive effect of previous attainment on retention is according to expectation. Score on a test of previous achievement in itself is an indication of retention. Obviously, students high in ability to retain the learned material will be better in retention on all occasions.

The finding that the variable rigidity-flexibility does not affect the retention scores of students taught by programmed instruction or by conventional method of teaching might be expected as the variable has no direct effect on achievement either.

The study reveals highly positive effect of good study habits on retention. It is interesting to recall here that study habits have no effect on achievement. It may be argued in this connection that students with poor study habits are benefitted by the psychological principles underlying programmed instruction to the extent that the effect of study habits on achievement has disappeared. The reason for the effect of study habits on retention may be the fact that during the period between post-test and delayed retention test students with good study habits might have mentally, or actually, reviewed the subject matter already learnt. This in turn might have revived their knowledge and resulted into better retention than by those who have poor study habits.

To sum up the educational implications of the present study, it may be said with confidence that school pupils, irrespective of their intelligence, study habits, previous achievement and personality characteristics, like introversion-extroversion and rigidity-flexibility, will achieve higher and retain better through programmed instruction than through the usual method of classroom teaching.

Further, programmed instruction is proved to be highly beneficial to flexible students as far as achievement is concerned and to intelligent students with good study habits for better retention over a period of time.

The study has also shown that in many cases, pupils with low intelligence when taught by programmed instruction achieve better than pupils with high intelligence and taught by conventional method. The study, thus, advocates the adoption of programmed instruction for pupils of all ability levels and with varied personal characteristics, and demonstrates that this method may be used as a powerful tool in remedying low achievement by low-ability students.

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Appendix - A Previous Achievement Test

छात्र का नाम - - - - - - - - - - - - - कक्षा - - ।

विद्यालय - - - - - - - - - - - - - - -

Pre. Ach. Test

Q1. $ax^2+bx+c=0$ में x का मान होगा

A. $(b \pm \sqrt{b^2-4ac}) \div 2a$ B. $\{-b \pm (b^2-4ac)\} \div 2a$

C. $(-b \pm \sqrt{b^2-4ac}) \div 2a$ C. $\{b-4ac\} \div 2a$

Q2. निम्न में से अभाज्य संख्याओं की श्रेणी कौन सी है-

A. 1, 2, 3, 4, ... B. 2, 4, 6, 8, ...

C. 1, 3, 5, 7, ... D. 3, 5, 7, 11 . . . . .

Q3. निम्न में से कौन सा कथन सत्य है-

A. $4 > 7$ B. $6 > 5$

C. $3 = 4$ D. $4 \neq 4$

Q4. निम्न में से कौन सी प्राकृत संख्या है

A. 0, 1, 2, 3 . . . . B. 1, 2, 3, 4 . . . . .

C. 3, 5, 7 . . . . D. $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}$ . . . . . .

Q5. 1+2+4+8 . . . . . . में सात पदों तक योग होगा

A. 120 B. 127

C. 125 D. 121

Q6. समीकरण $-x+2=-2x+4$ में x का मान है

A. 2 B. −2

C. 6 D. $\frac{1}{2}$

Q7. यदि a, b, और c समानान्तर श्रेणी में हों तो

A. $\frac{b}{a} = \frac{c}{b}$ B. $b-a=c-b$

C. $a \times b = b \times c$ D. $c^2 = ab$.

Q8. $x^2-9=0$ को हल करने पर x का मान होगा।

A. 3 B. −3

C. ±3 D. 9

Q9. $\frac{x}{3}=12$ तो x बराबर होगा

A. $12 \div 3$ B. 12×3

C. $12-3$ D. $12+3$

Q10. सम एवं विषम प्राकृत संख्याओं की श्रेणी को मिलाने पर नई श्रेणी बनेगी

A. प्राकृत संख्याएं B. सम संख्याएं

C. पूर्ण संख्याएं D. अभाज्य संख्याएं

Q11. x^2+2x+1 के गुणन खंड हैं

A. $(x-1)^2$ B. $(x+1)^2$

C. $(x+1)(x+2)$ D. $(x-1)(x+2)$

Q12. $x^2+5x+6=0$ को हल करने पर x का मान होगा-

A. −2, 3 B. 2, −3

C. −2, −3 D. 2, 3

Q13. $(x+a)^2 = x^2+4x+4$ तो a का मान होगा

A. 1 B. 2

C. 3 D. 4

Q14. व्यंजक $36x^4 + \ldots + 9$ को पूर्ण वर्ग बनाने के लिए रिक्त स्थान में रखेंगे-

A. $6x^2$ B. $12x^2$

C. $18x^2$ D. $36x^2$

Q15. $x^2+4x+4=0$ को हल करने पर x का मान प्राप्त होगा

A. 2, −2 B. −3, −1

C. −2 D. 2

Q16. प्रथम पद 2 तथा सार्वअन्तर 3 से समानान्तर श्रेणी बनाने के लिए 2 में 3 का लगातार-

A. गुणा करेंगे B. भाग देंगे

C. जोड़ करेंगे D. वर्ग जोड़ेंगे

Q17. सम प्राकृत संख्याओं की श्रेणी में प्रत्येक पद में 2 का भाग देने पर प्राप्त होगा-

Q18. विषम प्राकृत संख्याओं की श्रेणी निम्न में से कौन सी है-

A. 0, 1, 2, 3, 4 . . . . B. 1, 3, 5, 7 . . . . .

Q21. $7x+9=4x+3$ को हल करने के लिए प्रथम क्रिया होगी
A. $7x-4x=3-9$ B. $4x=7x-3+9$
C. $\frac{1}{7}(7x+9)=\frac{1}{7}(4x+3)$ D. $7x+9-4x-3=0$

Q22 5 किलो ग्राम के ग्राम निम्नलिखित होंगे
A. 5×10^4 B. 5×10^3
C. 5×10^2 D. 5×10^5

Q23 श्रेणी $-5,-1,3,\ldots$ में सार्वअन्तर होगा
A. 4 B. −4 C. 2 D. −2

Q24 $a^m \cdot a^n$ बराबर है−
A. $a^{m.n}$ B. a^{m-n} C. a^{m+n} D. $a^{m/n}$

Q25. $25^{-\frac{1}{2}}$ को सरल रूप में लिख सकते हैं
A. 5 B. $\frac{1}{5}$ C. 1 D. 0

Q26 $.2x=1.2$ तो x का मान होगा
A. .6 B. 6 C. .02 D. .2

Q27 यदि $x=10$ तो $\frac{x}{.02}$ का मान होगा
A. 200 B. 300 C. 400 D. 500

Q28. x^2+144y^2 में क्या जोड़े कि पूर्ण वर्ग बन जाये
A. $12xy$ B. $24xy$ C. $36xy$ D. $48xy$

Q29. $(x-1)(b-1)=0$ में यदि x का मान 1 तथा $\frac{1}{2}$ हो तो b का मान होगा
A. x B. $2x$ C. $-2x$ D. $-x$

Q30 $\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}\ldots\ldots$ में सार्व−अनुपात है
A. 1 B. $\frac{1}{2}$ C. $\frac{1}{3}$ D. $\frac{1}{4}$

Q31 पूर्ण वर्ग प्राकृत संख्याओं की श्रेणी कौन सी है−
A. 1,3,5,7..... B. 1,4,9,16.....
C. 2,4,8,16..... D. 0,4,9,16.....

Q32 निम्नलिखित में से कौन सा द्विघात समीकरण है−
A. $x^2-25x-84=0$ B. $x+25=0$
C. $\frac{x}{2}=6$ D. $3x=\frac{4}{5}$

Q33. निम्नलिखित में से कौन पूर्ण वर्ग है−
A. $4x^2-10xy+25y^2$ B. $4x^2+20xy-25y^2$
C. $4x^2-20xy+25y^2$ D. $4x^2+30xy+25y^2$

Q34 $x^2+8x-20=0$ का एक गुणन खंड $x-2$ हो तो दूसरा खण्ड होगा
A. $x+10$ B. $x-10$ C. $x-6$ D. $x+6$

Q35 $(x+3)(x-3)$ निम्नलिखित में से किसके गुणन खंड हैं
A. x^2+9 B. x^2-9
C. x^2+6x+9 D. x^2-6x+9

Q36 यदि 1 जूल = 10^7 अर्ग तो 10^{-4} जूल के अर्ग होंगे −
A. 10^3 अर्ग B. 10^4 अर्ग
C. 10^5 अर्ग D. 10^6 अर्ग

Q37. $x^{3/4}\times x^{1/4}\times x$ को सरल करने पर प्राप्त होगा− A. x B. x^2 C. x^3 D. x^4

Q38 $\frac{a^2-b^2}{a+b}$ का सरल मान होगा
A. $a+b$ B. $a-b$ C. a^2+b^2 D. a^2-b^2

Q39 $a^{m/n}$ को लिख सकते हैं
A. $\sqrt[mn]{a}$ B. $\sqrt{a^{mn}}$
C. $\sqrt[m]{a}$ D. $\sqrt[n]{a^m}$

Q40 निम्नलिखित में से कौन सी गुणोत्तर श्रेणी है−
A. 1+3+5+7.... B. 1+2+5+8......
C. 1+2+4+8.... D. $1+\frac{1}{2}+\frac{1}{6}+\frac{1}{18}\ldots$

Q41 एक घोड़ा 21 मीटर रस्सी से बंधा है वह निम्न क्षेत्रफल की घास खा सकेगा
A. 21π वर्ग मी. B. 42π वर्ग मी.
C. 10.5π वर्ग मी. D. 63π वर्ग मी.

Q42 $(x+a)(x-5)=0$ में $x=5$ तथा 4 तो a का मान होगा
A. 2 B. −3
C. −4 D. 5

Q43 गुणोत्तर श्रेणी में सार्व अनुपात ज्ञात करने के लिए दूसरे पद में प्रथम पद का
A. गुणा करेंगे B. भाग देंगे
C. वर्ग जोड़ेंगे D. दुगना घटायेंगे

Q44. यदि a, b, और c गुणोत्तर श्रेणी में हों तो निम्न में कौन सा कथन सत्य है−
A. $b^2=ac$ B. $ab=c$
C. $c^2=ab$ D. $a^2=bc$

Appendix - B Post Achievement Test

Post Achievement Test

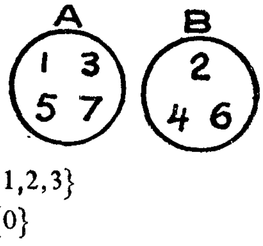
Department of Education, Aligarh Muslim University Aligarh

नाम..कक्षा.............. आयु..............

विद्यालय... दिनांक.........................

घर का पता... समय : 1 घण्टा

जब तक न कहा जाय आगे न लिखे—

1. यदि A={1,2,3,4}, B={2,4,6,7} तो "A संघ B" का मान है
   i {1,2,3,4,5}　　ii {1,2,3,4,5,6}
   iii {1,2,3,4,6,7}　　iv {1,3,6,7}
2. यदि A एक समुच्चय है तो A–A का मान होगा–
   i 0　　ii A
   iii ϕ　　iv {0}
3. यदि A={1,3,5,7} व B={2,4,6} तो A $\cup$ B का मान होगा।
   i {1,2,3,4,5}　　ii {1,2,3,4,5,6}
   iii {1,2,3,4,5,6,7}　　iv {1,2,3,4,5,6,7,8}
4. यदि {a,b,c,d} के उप समुच्चय बनाये तो दो अवयव के कितने उप समुच्चय बनेगे—
   a 3　b 4　c 5　d 6
5. यदि किसी समुच्चय में n अवयव हो तो उप समुच्चयों की संख्या है
   a 2n　　b n^2
   c 2　　d n
6. यदि  तो A $\cap$ B का मान होगा।

   i {1,2,3}　　ii {4,5,6}
   iii {0}　　iv { }

7. A तथा इस के उप समुच्च B का सर्व निष्ठ समुच्चय होगा ।

i A   ii B

iii A—B   iv A+B

8. निम्न में से कौनसा कथन असत्य है

i $A \cup A' = \cup$ ii $\phi \cup \phi = \phi$

iii $A \cup \phi \neq A$ iv $A \cup A \neq \cup$

9. चार सरल रेखा से बनी आकृती का समुच्चय होगा

a {चतुर्भुज}   b {वृत}   c {त्रिभुज}   d {रेखाएँ}

10. 105 के अभाज्य गुणन खंडों का समूच्चय है

a {1,3,5,7}   b {3,5,7}

c {15,7}   d {35, 3}

11. A संघ B को प्रतीक में निम्न प्रकार से लिखेंगे

i $A \cap B$ ii $A \cup B$

iii $A \subset B$ iv $A \supset B$

12. निम्नलिखित में से कौन सा कथन असत्य है

a $3 \in \{1,3,5,7\}$ b $3 \notin \{4,5,6\}$

c $2 \in \{2,4,6\}$ d $2 \notin \{2,4,6\}$

13. निम्नलिखित में से सुपरिभाषित समुच्चय कौन से है

a आपके शहर में धनवान व्यक्तियों का ससुच्चय

b तीव्र बुद्धि के छात्रों का समुच्चय

c प्राकृत संख्याओं समुच्चय

d गणित के उपयोगी सूत्रों का समुच्चय

14. कथन "3 अवयव नहीं है {2,4,6} का" को संकेत में लिखेंगे

a $3 \in \{2,4,6\}$ b $3 \in \{2, 4, 6\}$

/c $3 \notin (2,4,6)$ d $3 \not\ni$ (2,4,6)

15. यदि $E = \{2,4,6 \cdots\}$ तथा $N = \{1,2,3 \cdots\}$ तो निम्न में कौन सा ठीक है

a $E \not\subset N$ b $E \times N = \phi$

c $N - E = \phi$ d $E \subset N$

16. निम्न में कौन सा कथन सत्य है

a. $a \in \{x,y,z\}$ b. $8 \notin \{x | x=2n, n \in N\}$

c. आयत $\notin$ {समानान्तर चतुर्भुज} d. वर्ग $\in$ {सम चतुर्भुज}

17. $\{a,b\}$ के सर्व उप समुच्चय है

a $\{a\}, \{b\}$ b $\{a\}, \{b\}, \{a,b\}$

c $\{a\}, \{b\}, \{b,a\}, \{0\}$ d $\{a\}, \{b\}, \{a,b\}, \phi$

18. $\cup$ एक सार्वत्रिक समुच्चय तथा A एक समुच्चय है तो A का पूरक समुच्चय है

i $A-\cup$ ii $\cup-A$

iii $A\times\cup$ iv $\cup+A$

19. रिक्त समुच्चय वह है जिसका

a अवयव ϕ हो b अवयव 0 हो

c कोई भी अवयव न हो d अवयव संख्या न हो

20. यदि $M=\{1,3,5,7,9\}$ तथा $N=\{1,2,3,5,7\}$ तो $M\cap N$ को लिख सकते है

a 1,3,5,7 b $\{1,3,5,7\}$ c 2,9 d $\{2,9\}$

21. निम्न में से कौनसा रिक्त समुच्चय है

a सन् 1973 में 29 दिन के माह का समुच्चय

b 3 और 11 के मध्य अभाज्य संख्या का समुच्चय

c 0 का समुच्य

d सामान्तर रेखाओं का समुच्चय

22. निम्नलिखित में से रिक्त समुच्चय कौन सा है

a $\{0\}$ b ϕ

c $\{\phi\}$ d 0

23 यदि $S=\{m,n\}$ तो निम्न में से कौन सा कथन सत्य है

a m [illegible] S b $\phi\subset S$

c $m\subset S$ d $n\subset S$

24. सर्वनिष्ठ का प्रतीक निम्न में से कौन सा है

a $\cup$ b $\supset$ c $\cap$ d $\subset$

25. निम्न में से किस में रिक्त समुच्चय प्राप्त होगा

a $\{1,2\}\cup\{3,4\}$ b $\{1,2\}-\{3,4\}$

c $\{1,2\}\cap\{3,4\}$ d $\{1,2\}\times\{3,4\}$

26. निम्न में से कौन सा कथन सत्य है

a $\phi \neq$ {7 और 8 के मध्य प्राकृत संख्या}

b $\phi \neq$ {21 के सम अभाज्य गुणनखंड}

c $\phi \in \{\ \}$ d $\phi \not\subseteq \{2,4,6,8\}$

27. यदिA={1,3,5,7,9}, B={2,4,8,16} औरC={1,4,9,16} तो 9 अवयव होगा

i A का ii A तथा B का

iii B व C का iv A तथा C का

28. यदि A={o} तथा B=ϕ तो निम्न में से कौनसा कथन सत्य है

i $A \cup B = \phi$ ii $A \cup B = \{\}$

iii $A \cup B = o$ iv $A \cup B = \{o\}$

29. A तथा ϕ का सर्वनिष्ट समुच्चय होगा

i A ii ϕ

iii $A + \phi$ iv $A - \phi$

30. यदि A={1,3,5,7,9} तो "5 अवयव है A का" को संकेत में लिखेगे

i $A \subset 5$ ii $5 \subset A$

iii $A \in 5$ iv $5 \in A$

31. M={2,3,4,5} व N={1,2,3,5,7} तो निम्न में से कौनसा कथन सत्य हैं

a $M \subset N$ b $M \in N$

c $M \not\subset N$ d $M = N$

32. समीकरण $x^2-5x+6=0$ में x के मानों का समुच्चय होगा

a {2,3} b {-2, 3}

c {3, -2} d {-2, -3}

33. समुच्चय A का स्वयं के साथ संघ करने पर मान प्राप्त होगा

i 2A ii A

iii A^2 iv O

34. 10 से कम विषम प्राकृत संख्याओं का समुच्चय होगा

a {3,5,7,9} b {1,3,5,7,9}

c {1,3,5,7} d {3,5,7}

35. यदि $A=\{1,3,5\}$ तथा $A'=\{2,4,6\}$ तो इनका सार्वत्रिक समुच्चय होगा

i $\{1,3,5,6\}$ ii $\{1,2,3,4\}$

iii $\{1,2,3,4,5,6\}$ iv ϕ

36. $X=\{a,e,i,o,u\}$ तथा $Y=\{a,i,u\}$ तो $X \cup Y$ का मान होगा

i $\{a,e,i,o,u\}$ ii $\{a,i,u\}$

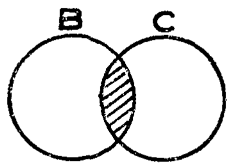
iii $\{a,e,i,o\}$ iv $\{\phi\}$

37. संख्या 1,2,3 में से दो अंक एक साथ लेने पर बने समुच्चयों की संख्या होगी

a दो   b तीन

c चार   d पाँच

38



में छायादार भाग निम्न को प्रदर्शित करता है।

i $B \cup C$ ii $B \supset C$ iii $B \cap C$ iv $B \subset C$

39. यदि $P=\{a,b,c,d\}$ और $Q=\{a,c\}$ तो निम्न में से कौन सा कथन सत्य है

a $P \cup Q=\phi$ b $P \cap Q=\phi$

c $Q \subset P$ d $P \subset Q$

40. निम्न में से कौन सा परिमित समुच्चय हैं

a दी गई रेखा के समानान्तर रेखाओं का समुच्चय ।

b 5 की गुणज संख्या का समुच्चय

c संकेन्द्र वृत्तों का समुच्चय

d वर्ष में महिनों के नामों का समुच्चय

41. $\{a,b,c\}$ के उप समुच्चयों की संख्या होगी–

a 2   b 2^2 c 2^3 d 2^4

42. निम्न मे से कौनसा समुच्चय नहीं हैं

a $\{1,2,3\}$ b $\{\ \}$ c ϕ d 4,5,6

43. $\{3,4\}$ के समस्त उप समुच्चय हैं

a $\{3\}, \{4\}$ b $\{3\}, \{4\}, \{3.4\}, \phi$

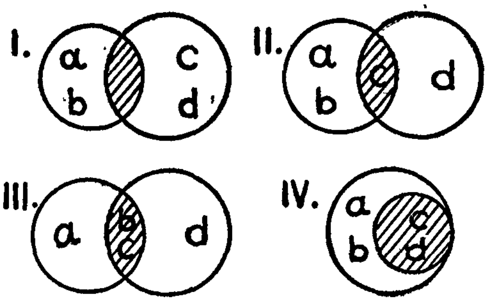
c $\{3\} \{4\}, \{3,4\}$ d $\{3\}, \{4\}, \{3,4\}, \{\phi\}$

44. यदि $A=\{2,3.4,5\}$ तथा $B=\{1,2,5,7\}$ तो $A-B$ का मान है

ı $\{1,7\}$ ii $\{2,3,4,7\}$

iii $\{1,3,4,7\}$ iv $\{3,4\}$

45. यदि $A=\{a,b,c,\}$, $B=\{b,c,d\}$ तो $A \cap B$ का वैन चित्र है



46. SCHOOL शब्द के अक्षरों का समुच्चय निम्न में कौन सा हैं

a {S,C,H,O,O,L} b {S,C,H,O,L}

c {S,L,H} d {S,C,H,L}

47. यदि $\cup$ सार्वत्रिक समुच्चय है तथा $A=\cup$ तो A' को कहेंगे

i पूरक समुच्चय ii सार्वत्रिक समुक्चय

iii शून्य का समुच्चय iv रिक्त समुच्चय

48. दो समुच्चय का संघ वह है जिसमें

a दोनों समुच्चय के अवयव हो

b दोनों समुच्चय के अवयव न हो

e दौनों समुच्चय के सर्वनिष्ठ अवयव हो

d दौनों के सर्वनिष्ठ अवयब न हो

49 निम्न में से कौन सा सम्बन्ध ठीक है

a $(x : x$ चार तक प्राकृत संख्या$\}=\{1,2,3,4\}$

b $\{x : x$ सम अभाज्य संख्या$\}=\{2\}$

c $\{x : x$ सम प्राकृत संख्या$\}=\{2,4,6\cdots\cdots\}$

d $\{x : x$ दस से बड़े पूर्णाङ्क$\}=\{12,13,14\cdots\cdots\}$

50. यदि समुच्चय A तथा B क्रमशः 6 तथा अवयव रखते हो तथा B के सब अवयव A' में उपस्थित हो तो $A \cup B$ में अवयवों की संख्या होगी

a 10 b 2

c 6 d 4

Appendix - C Delayed Test of Achievement
(Post achievement test - II)

[............]

Post Achievement Test (II)

Department of Education, Aligarh Muslim University, Aligarh

नाम.......................................कक्षा................आयु................

विद्यालय..दिनांक........................

घर का पता...

जब तक न कहा जाय आगे न लिखें—

1. यदि A={2,3,4,5}, B={3,5,7,8} तो "A संघ B" का मान है
   i {2,3,4,5,6} ii {2,3,4,5,6,7}
   iii {2,3,4,5,7,8} iv {2,4,7,8}

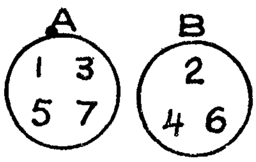
2 यदि P एक समुच्चय है तो P–P का मान होगा-
   i 0 ii P
   iii {0} iv ϕ

3. यदि A={9,3,5,7} व B={8,6,4} तो $A \cup B$ का मान होगा।
   i {3,4,5,6,7} ii {3,4,5,6,7,8}
   iii {3,4,5,6,7,8,9} iv {3,4,5,6,7,8,9,10}

4 यदि {b,c,d,e} के उप समुच्चय बनायें तो दो अवयव के कितने उप समुच्चय बनेगे-
   a 3 b 4 c 5 d 6

5. यदि किसी समुच्चय में n अवयव हो तो उप समुच्चयों की संख्या होगी
   a 2n b n^2
   c 2^n d n

6. यदि



तो $A \cup B$ का मान होगा-

   i {4,5,6} ii { }
   iii {1,2,3} iv {0}

7. A तथा इसके उप समुच्चय C का सर्वनिष्ठ समुच्चय होगा–

i C　　ii A

iii $A+C$　　iv $A-C$

8. निम्न में से कौन सा कथन असत्य है–

i $M \cup M' = \cup$　　ii $\phi \cup \phi = \phi$

iii $A \cup \phi \neq A$　　iv $M \cup M \neq \cup$

9. चार सरल रेखा से बनी आकृती का समुच्चय है–

a {रेखायें}　b {वृत}　c {चतुर्भुज}　d {त्रिभुज}

10. 105 के अभाज्य गुणन खडों का समुच्चय है–

a $\{1,3,5,7\}$　　b $\{7,15\}$

c $\{35,3\}$　　d $\{3,5,7\}$

11. B संघ C को प्रतीक में निम्न प्रकार से लिखेंगे–

i $B \cap C$　　ii $B \cup C$

iii $B \subset C$　　iv $B \supset C$

12. निम्नलिखित में कौन सा कथन असत्य है।

a $4 \in \{2,4,6,8\}$　　b $4 \notin \{5,6,7\}$

c $3 \in \{3,5,7\}$　　d $3 \notin \{3,5,7\}$

13. निम्नलिखित में से सुपरिभाषित समुच्च कौन से है

a आपके शहर में धनवान व्यक्तियों का समुच्चय

b प्राकृत संख्याओं का समुच्चय

c तीव्र बुद्धि के छात्रों का समुच्चय

d गणित के उपयोगी सूत्रों का समुच्चय

14. कथन "5 अवयव नहीं है $\{2,4,6\}$ का" को संकेत में लिखिये

a $5 \in \{2,4,6\}$　　b $5 \ni \{2,4,6\}$

c $5 \notin \{2,4,6\}$　　d $5 \not\ni \{2,4,6\}$

15. यदि $E=\{2,4,6\cdots\cdots\}$ तथा $N=\{1,2,3\cdots\cdots\}$ तो निम्न में कौन सा कथन ठीक है।

a $E \not\subset N$　　b $E \times N = \phi$

c $E \subset N$　　d $N - E = \phi$

16. निम्न में कौनसा कथन सत्य है—

a $a \in \{x,y,z\}$ b आयत $\notin$ {समानान्तर चतुर्भुज}

c वर्ग $\in$ {समचतुर्भुज} d $8 \notin \{x:x=2n,\ n \in N\}$

17. {a,b} के सर्व उप समुच्चय है—

a {a}, {b} b {a}, {b}, {b,a}, {0}

c {a}, {b}, {a,b} d {a}, {b}, {a,b}, ϕ

18. S एक सार्वत्रिक समुच्चय तथा B उसका एक समुच्चय है तो B का पूरक समुच्चय हैं।

i B—S ii S—B

iii $B \times S$ iv $S+B$

19. रिक्त समुच्चय वह है जिसका—

a अवयव 0 हो b अवयव ϕ हो

c अवयव संख्या न हो d कोई भी अवयव न हो।

20. यदि $P=\{1,3,5,7,9\}$ तथा $Q=\{1,2,3,5,7\}$ तो $P \cap Q$ को

a 1,3,5,7 b {1,3,5,7} c 2,9 d {2,9}

21. निम्न में से कौनसा रिक्त समुच्चय है—

a समानान्तर रेखाओं का समुच्चय

b 3 और 11 के मध्य अभाज्य संख्या का समुच्चय

c सन् 1973 में 29 दिन के माह के समुच्चय

d 0 का समुच्चय

22. निम्नलिखित में से रिक्त समुच्चय कौन सा है-

a {o} b ϕ

c $\{\phi\}$ d o

23. यदि $S=\{e,f\}$ तो निम्न में से कौन सा कथन सत्य है।

a $e \not\subset S$ b $\phi \subset S$

c $e \subset S$ d $f \subset S$

24. सर्वनिष्ठ का प्रतीक निम्न में से कौन सा है—

a $\subset$ b $\cup$ c $\supset$ d $\cap$

25. निम्न में से किस में रिक्त समुच्चय प्राप्त होगा—

a $\{a,b\} \cap \{c,d\}$ b $\{a,b\}-\{c,d\}$

c $\{a,b\} \cup \{c,d\}$ d $\{a,b\} \times \{c,d\}$

26. निम्न में से कौन सा कथन सत्य है—

a $\phi \neq$ {8 और 9 के मध्य प्राकृत संख्या}

b $\phi \neq$ {33 के सम अभाज्य गुणज खंड}

c $\phi \not\subseteq \{1,3,5,7\}$ d $\phi \in \{\ \}$

27. यदि $A=\{2,4,6,8,10\}$, $B=\{2,4,16,18\}$ और $C=\{1,5,8\}$ तो 8 अवयव होगा—

i A का ii A तथा B का

iii B व C का iv A तथा C

28. यदि $R=\{0\}$ तथा $Q=\phi$ तो निम्न मे से कौनसा कथन सत्य है-

i $R \cup Q=\phi$ ii $R \cup Q=\{\ \}$

iii $R \cup Q=0$ iv $R \cup Q=\{0\}$

29. D तथा ϕ का सर्वनिष्ठ समुच्चय होगा—

i D ii ϕ

iii $D+\phi$ iv $D-\phi$

30. यदि $A=\{2,4,6,8,10\}$ तो "6 अवयव है A का" को संकेत में लिखेंगे—

i $A \subset 6$ ii $6 \subset A$

iii $A \in 6$ iv $6 \in A$

31. $A=\{2,3,4,5\}$ व $B=\{1,2,3,5,7\}$ तो निम्न में से कौनसा कथन सत्य हैं-

i $A \subset B$ ii $A \in B$

iii $A \not\subset B$ iv $A=B$

32. समीकरण $x^2-10x+21=0$ में x के मानों का समुच्चय होगा-

a $\{3,7\}$ b $\{-3,7\}$

c $\{3,-7\}$ d $\{-3,-7\}$

33. M का स्वयं के साथ संघ करने पर मान प्राप्त होगा-

i 2M ii M

iii M^2 iv O

34. 11 से कम विषम प्राकृत संख्याओं का समुच्चय होगा—

a $\{1,3,5,7\}$ b $\{1,3,5,7\ 9\}$

c $\{3,5,7,9,11\}$ d $\{1,3,5,7,9,11\}$

35. A={3,5,7} तथा A'={4,6,8} तो इनका सार्वत्रिक समुच्चय होगा

i {3,5,7,8} ii {1,2,3,4,5,6,7,8}

iii {3,4,5,6,7,8} iv ϕ

36. X={a,b,d,f} तथा Y={a,d} तो $X \cup Y$ का मान होगा

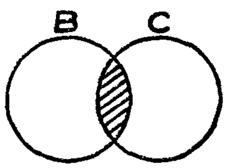
i {a,b,d,f} ii {a,d}

iii {a,b,d} iv ϕ

37. a,b,c में से कोई दो एक साथ लेने पर बने समुच्चयों की संख्या होगी

a दो b तीन

c चार d पाँच

38. 

में छायादार भाग निम्न को प्रदर्शित करता हैं।

i $B \cap C$ ii $B \cup C$ iii $B \supset C$ iv $B \subset C$

39. यदि P={a,b,c,d} और Q={b,d} तो निम्न में कौन सा कथन सत्य है।

a $P \cap Q = \phi$ b $P \cup Q = \phi$

c $Q \subset P$ d $P \subset Q$

40. निम्न में से कौन सा परिमित समुच्चय है-

a सकेन्द्र वृत्तों का समुच्चय

b वर्ष में महिनों के नामों का समुच्चय

c दी गई रेखा के सामानान्तर रेखाओं का समुच्चय

d 5 की गुणज संख्याओं का समुच्चय

41. {1,2,4} के उप समुच्चयों की संख्या होगी-

a 2^2 b 2^3 c 2^4 d 2

42 निम्न में से कौनसा समुच्चय नहीं हैं

a {1,2,4} b ϕ c { } d 3,5,7

43 {5,6} के समस्त उप समुच्चय है—

a {5}, {6} b {5}, {6}, {5,6}

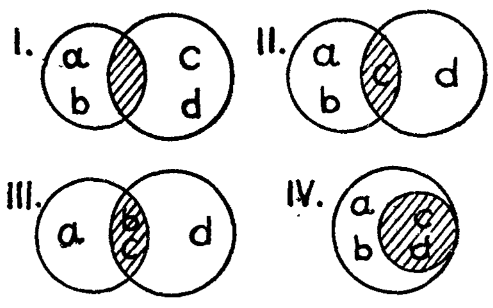
c {5}, {6}, {5,6}, ϕ d {5}, {6}, {5,6}, {ϕ}

44. यदि A={3,4,5.6} तथा B={2,3,6,8} तो A-B का मान है ।

i {2,8} ii {3,4,5,8}

iii {2,4,5,8} iv {4,5}

45. यदि A={a,b,c}, B={b,c,d} तो A ∩ B का वैन चित्र है ।



46. EVENING शब्द के अक्षरों का समुच्चय निम्न में कौन सा है ।

a {E,V,E,N,I,N,G} b {E,V,N,I,G}

c {E,V,G} d {V,E,N,G}

47. ∪ एक सार्वत्रिक समुच्चय है तथा ∪ =A तो A' को कहेंगे–

a सार्वत्रिक समुच्चय b पूरक समुच्चय

c शून्य का समुच्चय d रिक्त समुच्चय

48. समुच्चय का संघ वह है जिसमें—

a दोनों समुच्चय के अवयव न हों ।

b दौनों समुच्चय के सर्वनिष्ठ अवयव हों ।

c दौनों के सर्वनिष्ठ अवयव न हो ।

d दौनों समुच्चय के अवयव हों ।

49. निम्न में से कौन सा सम्बन्ध ठीक नहीं है ।

a {x : x सात तक प्राकृत संख्या} = {1,2,3,4,5,6,7}

b {x : x सम अभाज्य संख्या} = {2}

c {x : x विषय प्राकृत संख्या} = {1,2,3,4,5............}

d {x : x पाँच से बड़े पूर्णाङ्क} = {6,7,8,9.......... }

50. यदि समुच्चय A तथा B क्रमशः 7 तथा 3 अवयव रखते हों तथा B के सब अवयव A में उपस्थित हों तो A ∪ B से अवयवों की संख्या होगी ।

a 10 b 4

c 3 d 7

Appendix - D Tables 1-10 Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance

Table No.1. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Previous Achievement (A)		Study habit(S) Good study habits (S_1)	Study habit(S) Poor study habits (S_2)
High pre achievement (A_1)	Programmed Instruction (M_1)	31, 30, 37, 20, 45, 23, 35, 39, 41, 41, 40, 33, 45, 41, 39, 23, 40, 39, 41, 39 Mean:(37.3) Total = 746	32, 36, 31, 30, 41, 32, 42, 38, 43, 39, 35, 39, 37, 29, 36, 38, 23, 41, 37, 39 Mean (36.1) Total = 722
	Conventional method (M_2)	25, 39, 22, 18, 28, 20, 26, 23, 30, 22, 26, 25, 27, 24, 34, 36, 23, 35, 32, 32 Mean:(27.7) Total = 554	33, 26, 25, 26, 24, 19, 30, 25, 16, 30, 23, 24, 27, 29, 23, 16, 19, 16, 19, 30 Mean:(24.1) Total = 482
Low Pre achievement (A_2)	Programmed Instruction (M_1)	31, 29, 23, 30, 31, 30, 26, 26, 34, 26, 30, 30, 31, 31, 34, 35, 35, 34, 35, 33 Mean:(31.2) Total = 624	33, 32, 31, 34, 34, 40, 47, 40, 36, 34, 33, 41, 23, 41, 37, 26, 35, 34, 40, 35 Mean:(34.8) Total = 696
	Conventional method (M_2)	27, 18, 31, 13, 17, 23, 18, 21, 31, 15, 32, 14, 34, 29, 31, 21, 17, 21, 19, 23 Mean:(33.2) Total = 445	23, 21, 24, 11, 16, 21, 20, 22, 12, 20, 16, 20, 27, 20, 22, 20, 28, 20, 19, 16 Mean:(19.9) Total = 398
	Grand Totals	A_1 Total = 2505 (Mean = 31.31) M_1 Total = 2789 (Mean = 34.86) A_2 Total = 2163 (Mean = 27.03) M_2 Total = 1879 (Mean = 23.48)	S_1 Total = 2369 (Mean = 29.61) S_2 Total = 2299 (Mean = 28.73)

Table No. 2. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance

Study habits (S)		Rigidity (R) High rigidity (R_1)		Low rigidity (R_2)	
Good Study habits (S_1)	Programmed Instruction (M_1)	34, 34, 33, 31, 28 35, 42, 35, 32, 34 Mean:(33.7)	Total = 337	30, 37, 39, 33, 35, 35, 34, 42, 40, 39 Mean:(36.9)	Total = 369
	Conventional method (M_2)	25, 13, 17, 25, 18 29, 38, 35, 32, 28 Mean:(25.3)	Total = 255	23, 23, 23, 24, 21, 27, 25, 30, 14, 29 Mean =(24.6)	Total = 246
Poor Study habits (S_2)	Programmed Instruction (M_1)	33, 27, 35, 40, 47 43, 44, 32, 28, 39 Mean:(36.4)	Total = 364	32, 34, 29, 40, 38, 34, 34, 38, 35, 40 Mean:(34.4)	Total = 344
	Conventional method (M_2)	21, 24, 26, 20, 24, 28, 30, 22, 25, 21 Mean:(23.1)	Total = 231	18, 20, 23, 22, 27, 27, 28, 19, 22, 30 Mean:(24.2)	Total = 242

R_1 Total =1187 (Mean=29.67) S_1 Total=1207 (Mean=30.17) M_1 Total=1414 (Mean=35.35)

R_2 Total =1201 (Mean=30.02) S_2 Total=1181 (Mean=29.52) M_2 Total=974 (Mean =24.35)

Table No. 3. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Rigidity (R)		Introversion (In): High introversion (In_1)	Introversion (In): Low introversion (In_2)
High rigidity (R_1)	Programmed Instruction (M_1)	34, 31, 33, 35, 48, 46, 32, 31 33, 23, 42, 34, 46, 33, 39. Mean:(36.2) Total = 544	34, 30, 33, 26, 34, 32, 26, 31, 25, 31, 33, 31, 30, 41, 28 Mean:(31.3) Total = 470
	Conventional method (M_2)	27, 27, 29, 23, 27, 20, 29, 35 39, 21, 25, 24, 32, 21, 39 Mean=(28.2) Total = 423	20, 21, 24, 25, 25, 39, 13, 25, 24, 24, 25, 20, 27, 24, 28 Mean=(24.2) Total = 384
Low rigidity (R_2)	Programmed Instruction (M_1)	32, 41, 43, 34, 43, 31, 37, 35 42, 41, 33, 40, 28, 28, 37. Mean=(36) Total = 540	30, 31, 34, 34, 33, 35, 39, 33 32, 33, 35, 38, 35, 34, 39. Mean=(34.6) Total = 519
	Conventional method (M_2)	23, 29, 29, 28, 18, 20, 22, 34 14, 22, 22, 28, 31, 19, 22. Mean=(24.4) Total = 367	23, 26, 21, 18, 16, 25, 15, 23, 27, 19, 14, 12, 34, 21, 20. Mean=(21.5) Total = 323

In_1 Total=1874 (Mean=31.23) R_1 Total=1801 (Mean=30.01) M_1 Total=2073 (Mean=34.55)

In_2 Total=1676 (Mean=27.93) R_2 Total=1749 (Mean=29.15) M_2 Total=1477 (Mean=24.61)

Table No. 4. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Intelligence (I)		Study habits (S): Good study habits (S_1)		Poor study habits (S_2)	
High intelli-gence (I_1)	Programmed Instruction (M_1)	37, 33, 35, 41, 38, 40, 45, 39, 34, 41 Mean=(38.3)	Total = 383	34, 47, 44, 39, 38 37, 38, 23, 28, 39 Mean=(37.0)	Total = 370
	Conventional methods (M_2)	25, 22, 22, 21, 23 30, 22, 29, 34, 23 Mean=(25.3)	Total = 253	33, 26, 23, 30, 27 23, 22, 25, 21, 19 Mean=(25.4)	Total = 254
Low intelli-gence (I_2)	Programmed Instruction (M_1)	30, 29, 32, 31, 41 31, 26, 24, 35, 40. Mean=(31.9)	Total = 319	32, 33, 22, 31, 40, 41, 31, 35, 36, 41. Mean=(34.2)	Total = 342
	Conventional methods (M_2)	27, 23, 26, 32, 21, 27, 31, 20, 21, 32. Mean=(24.0)	Total = 240	23, 21, 24, 17, 21, 16, 20, 25, 28, 22. Mean=(21.7)	Total = 217

S_1	Total=1195 (Mean=29.87)	I_1	Total=1260 (Mean=31.50)	M_1	Total=1414 (Mean=35.35)
S_2	Total=1183 (Mean=29.57)	I_2	Total=1118 (Mean=27.95)	M_2	Total= 964 (Mean=24.10)

Table No.5. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Intelligence (I)		Rigidity (R): High rigidity (R_1)		Low rigidity (R_2)	
High intelligence (I_1)	Programmed Instruction (M_1)	34, 36, 35, 47, 44, 39, 28, 26, 46, 39.		37, 42, 34, 38, 38, 38, 37, 34, 38, 40	
		Mean=(37.4)	Total = 374	Mean=(37.6)	Total = 376
	Conventional method (M_2)	35, 26, 24, 24, 32 29, 34, 36, 37, 30.		18, 21, 27, 19, 34 22, 34, 31, 19, 20	
		Mean=(29.7)	Total = 297	Mean=(24.5)	Total = 245
Low intelligence (I_2)	Programmed Instruction (M_1)	32, 31, 41, 31, 40, 34, 40, 26, 41, 42		30, 22, 31, 41, 35, 32, 33, 35, 36, 40.	
		Mean=(34.8)	Total = 348	Mean=(33.5)	Total = 335
	Conventional method (M_2)	27, 24, 27, 25, 37 23, 22, 17, 25, 32.		23, 21, 18, 29, 28 16, 21, 23, 27, 22.	
		Mean=(24.9)	Total = 249	Mean=(22.8)	Total = 228

R_1	Total=1259 (Mean=31.45)	I_1	Total=1282 (Mean=32.05)	M_1	Total = 1433 (Mean=35.82)
R_2	Total=1184 (Mean=29.6)	I_2	Total=1160 (Mean=29.0)	M_2	Total=1009 (Mean=25.22)

Table No. 6. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Intelligence (I)		Introversion (In): High introversion (In_1)		Introversion (In): Low introversion (In_2)	
High intelli-	Programmed	43, 36, 35, 38, 39,		45, 34, 35, 47, 42,	
	Instruction	48, 48, 46, 37, 39.		41, 41, 34, 41, 28.	
(I_1)	(M_1)	Mean=(40.9)	Total = 409	Mean=(38.8)	Total = 388
	Conventional	28, 26, 34, 32, 29,		33, 25, 25, 25, 19,	
	method	35, 23, 23, 22, 31.		22, 34, 24, 16, 28.	
	(M_2)	Mean=(28.8)	Total = 288	Mean=(25.1)	Total = 251
Low intelli-gence	Programmed	31, 41, 33, 34, 40,		30, 29, 33, 31, 32,	
	Instruction	35, 40, 26, 40, 42		28, 29, 31, 33, 36.	
(I_2)	(M_1)	Mean=(36.2)	Total = 362	Mean=(31.2)	Total = 312
	Conventional	23, 27, 27, 24, 29,		21, 24, 24, 28, 24,	
	method	28, 20, 21, 28, 20.		31, 18, 21, 17, 25.	
	(M_2)	Mean=(24.7)	Total = 247	Mean=(22.3)	Total = 223

In_1	Total=1306 (Mean=32.65)	I_1	Total=1336 (Mean=33.40)	M_1	Total=1471 (Mean=36.77)
In_2	Total=1174 (Mean=29.35)	I_2	Total=1144 (Mean=28.60)	M_2	Total=1009 (Mean=25.22)

Table No. 7. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Previous Achievement (A)		Rigidity (R): High rigidity (R_1)		Rigidity (R): Low rigidity (R_2)	
High pre-achievement (A_1)	Programmed Instruction (M_1)	37, 35, 32, 26, 27, 39, 28, 35, 30, 27, 35, 39, 28, 46, 39		30, 37, 36, 43, 39, 42, 38, 43, 45, 39, 39, 42, 38, 39, 40, 40	
		Mean=(33.5)	Total = 503	Mean=(39.2)	Total = 589
	Conventional method (M_2)	27, 26, 25, 39, 33, 25, 23, 24, 34, 36, 27, 25, 35, 32, 30.		23, 26, 37, 27, 28, 28, 26, 22, 27, 23, 25, 34, 31, 25, 19.	
		Mean=(29.5)	Total = 443	Mean=(26.6)	Total = 399
Low pre-achievement (A_2)	Programmed Instruction (M_1)	33, 33, 33, 31, 31, 30, 31, 25, 31, 47, 35, 41, 26, 33, 33.		22, 31, 34, 39, 38, 40, 36, 35, 33, 35, 33, 37, 35, 34, 40.	
		Mean=(32.8)	Total = 493	Mean=(34.0)	Total = 524
	Conventional method (M_2)	21, 24, 11, 13, 16, 17, 24, 20, 24, 20, 32, 29, 23, 24, 19.		23, 22, 22, 12, 16, 16, 15, 21, 23, 19, 19, 34, 14, 20, 16.	
		Mean=(21.06)	Total = 316	Mean=(19.6)	Total = 294

R_1 Total=1755 (Mean=29.25) A_1 Total=1934 (Mean=32.23) M_1 Total=2109 (Mean=35.15)

R_2 Total=1806 (Mean=30.10) A_2 Total=1627 (Mean=27.11) M_2 Total=1452 (Mean=24.20)

Table No. 8. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Previous achievement (A)		I n t r o v e r s i o n (In)			
		High Introversion (In_1)		Low Introversion (In_2)	
High pre-achievement (A_1)	Programmed Instruction (M_1)	44, 43, 45, 37, 35, 42, 48, 39, 46, 37		30, 29, 45, 28, 35, 42, 41, 41, 41, 39	
		Mean=(41.6)	Total = 416	Mean=(37.1)	Total = 371
	Conventional method (M_2)	27, 32, 18, 36, 28, 22, 23, 22, 31, 29.		33, 25, 25, 25, 30, 25, 22, 34, 16, 20.	
		Mean=(26.6)	Total = 266	Mean=(25.5)	Total = 255
Low pre-achievement (A_2)	Programmed Instruction (M_1)	43, 31, 34, 46, 39, 36, 46, 37, 34, 33.		33, 38, 34, 47, 38, 34, 35, 41, 33, 35.	
		Mean=(37.8)	Total = 378	Mean=(36.6)	Total = 366
	Conventional method (M_2)	22, 23, 24, 22, 20, 24, 25, 21, 28, 19.		24, 24, 16, 21, 18, 24, 23, 19, 24, 23.	
		Mean=(22.8)	Total = 228	Mean=(21.4)	Total = 214

In_1 Total=1288 (Mean=32.2) A_1 Total=1308 (Mean=32.7) M_1 Total=1531 (Mean=38.27)

In_2 Total=1206 (Mean=30.15) A_2 Total=1186 (Mean=29.65) M_2 Total= 963 (Mean=24.07)

Table No. 9. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Study habits (S)		Method	Introversion (In): High Introversion (In_1)		Low Introversion (In_2)	
Good study habits (S_1		Programmed Instruction (M_1)	33, 31, 34, 47, 39, 34, 34, 41, 33, 39. Mean=(36.7)	Total = 367	30, 32, 46, 23, 31, 41, 30, 41, 34, 39. Mean=(35.2)	Total = 352
		Conventional methods (M_2)	34, 34, 34, 31, 32, 29, 42, 40, 39, 33. Mean=(34.7)	Total = 347	25, 25, 23, 25, 13, 14, 22, 29, 29, 23. Mean=(22.9)	Total = 229
Poor study habits S_2		Programmed Instruction (M_1)	34, 34, 35, 43, 37, 35, 39, 37, 37, 39. Mean=(36.9)	Total = 369	33, 21, 24, 27, 16, 21, 20, 27, 25, 16. Mean=(23.0)	Total = 230
		Conventional methods (M_2)	23, 18, 21, 29, 30, 20, 25, 31, 19, 22. Mean=(23.7)	Total = 237	24, 22, 26, 24, 15, 25, 34, 23, 22, 21. Mean=(23.6)	Total = 236

In_1 Total=1320 (Mean=33.0) S_1 Total=1295 (Mean=32.37) M_1 Total=1318 (Mean=32.95)

In_2 Total=1047 (Mean=26.17) S_2 Total=1072 (Mean=26.80) M_2 Total=1049 (Mean=26.22)

Table No. 10. Distribution of achievement scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Intelligence (I)		Previous Achievement (A): High pre-achievement (A_1)		Previous Achievement (A): Low pre-achievement (A_2)	
High Intelligence (I_1)	Programmed Instruction (M_1)	45, 43, 39, 44, 41, 40, 45, 41, 33, 46.		26, 33, 47, 36, 36, 28, 26, 40, 35, 33.	
		Mean=(43.2)	Total = 433	Mean=(34.0)	Total = 340
	Conventional method (M_2)	33, 26, 19, 26, 23 30, 34, 36, 33, 31.		24, 24, 21, 27, 19, 32, 34, 29, 22, 24.	
		Mean=(29.1)	Total = 291	Mean=(25.6)	Total = 256
Low Intelligence (I_2)	Programmed Instruction (M_1)	30, 32, 29, 39, 32, 31, 33, 40, 26, 29.		38, 33, 38, 32, 23, 31, 30, 40, 35, 41.	
		Mean=(32.1)	Total = 321	Mean=(33.6)	Total = 336
	Conventional method (M_2)	27, 26, 28, 26, 31, 27, 30, 32, 32, 26.		23, 21, 24, 22, 21, 23, 42, 21, 29, 20.	
		Mean=(28.5)	Total = 285	Mean=(24.5)	Total = 245

A_1 Total=1319 (Mean=32.97) I_1 Total=1309 (Mean=32.72) M_1 Total=1413 (Mean=35.47)

A_2 Total=1177 (Mean=29.42) I_2 Total=1187 (Mean=29.67) M_2 Total=1077 (Mean=26.92)

Appendix - E Tables 11-20 Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance

Table No. 11. Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Previous Achievement (A)		Study habits (S): Good study habits (S_1)		Poor study habits (S_2)	
High pre-achievement (A_1)	Programmed Instruction (M_1)	33,32,32,33,29,20,40,33,38,18, 33,25,31,32,40,24,38,20,32,34		28,21,21,18,30,22,35,40,34,25 21,22,22,19,22,17,12,19,28,17	
		Mean=(31.4)	Total = 629	Mean=(23.6)	Total = 473
	Conventional method (M_2)	20,35,10,12,26,35,21,21,28,21, 21,22,23,29,21,31,16,29,35,20		27,27,22,23,24,28,28,22,18,18, 19,21,18,20,20,29,05,18,30,12.	
		Mean=(22.9)	Total = 459	Mean=(21.9)	Total = 439
Low pre-achievement (A_2)	Programmed Instruction (M_1)	29,23,19,23,22,19,21,24,22,22, 29,18,22,21,22,10,24,24,20,24.		32,20,34,27,25,41,32,27,31,27, 25,13,13,31,26,09,13,12,10,17.	
		Mean=(22.8)	Total = 456	Mean=(23.7)	Total = 475
	Conventional method (M_2)	26,19,25,18,13,22,18,14,17,20, 12,25,10,27,25,23,16,23,15,18		19,18,19,20,14,10,19,18,18,21, 16,11,20,10,17,10,12,12,11,18.	
		Mean=(19.3)	Total = 386	Mean=(15.6)	Total = 313

S_1 Total=1929 (Mean=24.11) A_1 Total=1993 (Mean=24.93) M_1 Total=2033 (Mean=25.41)

S_2 Total=1700 (Mean=21.25) A_2 Total=1630 (Mean=20.37) M_2 Total=1596 (Mean=19.95)

Table No. 13. Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance

Study habits (S)		Rigidity (R): High rigidity (R_1)		Rigidity (R): Low rigidity (R_2)	
Good study habits (S_1)	Programmed Instruction (M_1)	26, 27, 31, 29, 29, 28, 40, 22, 33, 24.		23, 32, 33, 18, 22, 19, 24, 33, 32, 28.	
		Mean=(29.7)	Total = 297	Mean=(27.2)	Total = 272
	Conventional methods (M_2)	20, 18, 13, 21, 12, 25, 36, 29, 30, 30.		17, 28, 23, 21, 20, 23, 22, 29, 16, 18.	
		Mean=(23.4)	Total = 234	Mean=(22.0)	Total = 220
Poor study habits (S_2)	Programmed Instruction (M_1)	33, 26, 29, 41, 32, 38, 39, 31, 09, 17,		20, 33, 25, 27, 29, 16, 27, 28, 30, 18	
		Mean=(27.8)	Total = 278	Mean=(25.3)	Total = 253
	Conventional methods (M_2)	18, 19, 23, 19, 18, 17, 11, 10, 20, 15.		21, 27, 23, 20, 20, 22, 19, 18, 09, 30.	
		Mean=(17.0)	Total = 170	Mean=(21.1)	Total = 211

R_1 Total = 969 (Mean=24.22) S_1 Total =1013 (Mean=25.32) M_1 Total =1090 (Mean=27.25)

R_2 Total = 956 (Mean=23.9) S_2 Total = 912 (Mean=22.8) M_2 Total = 835 (Mean=20.87)

Table No. 13. Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

		Introversion (In)			
		High introversion (In_1)		Low introversion (In_2)	
High rigidity (R_1)	Programmed Instruction (M_1)	23,29,37,23,41,28,35,33, 47,33,28,24,24,23,25.		28,33,29,27,32,31,19,20, 26,25,40,32,22,22,31.	
		Mean=(30.9)	Total = 464	Mean=(27.9)	Total = 419
	Conventional methods (M_2)	27,22,25,22,28,31,26,22, 27,22,30,18,35,25,25.		23,18,20,20,20,25,18,21, 18,20,21,13,32,19,30.	
		Mean=(25.0)	Total = 375	Mean=(21.1)	Total = 317
Low rigidity (R_2)	Programmed Instruction (M_1)	20,27,32,27,34,21,22,23, 33,24,30,32,19,17,26.		28,34,22,33,29,22,22,25, 29,25,19,23,18,12,26.	
		Mean=(26.4)	Total = 397	Mean=(24.7)	Total = 371.
	Conventional methods (M_2)	19,10,30,35,12,25,13,27, 15,19,10,19,26,18,09.		15,27,22,19,18,23,13,20, 21,10,16,10,24,12,18.	
		Mean=(18.4)	Total = 276	Mean=(17.8)	Total = 267

Rigidity (R)

In_1 Total=1512 (Mean=25.2) R_1 Total=1575 (Mean=26.25) M_1 Total=1651 (Mean=27.51)

In_2 Total=1374 (Mean=22.9) R_2 Total=1311 (Mean=21.85) M_2 Total=1235 (Mean=20.58)

Table No. 14. Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Intelligence (I)		Study habits (S): Good study habits (S_1)		Poor study habits (S_2)	
High intelligence (I_1)	Programmed Instruction (M_1)	32, 31, 25, 38, 19, 33, 32, 40, 24, 34. Mean=(30.8)	Total = 308	33, 32, 39, 23, 29, 23, 30, 09, 13, 17. Mean=(24.8)	Total = 248
	Conventional methods (M_2)	20, 20, 19, 17, 21, 29, 21, 25, 31, 18. Mean=(22.1)	Total = 221	27, 23, 17, 23, 20, 19, 10, 20, 06, 18 Mean=(18.8)	Total = 188
Low intelligence (I_2)	Programmed Instruction (M_1) M_1	28, 37, 17, 29, 33, 19, 22, 26, 23, 32. Mean=(26.5)	Total = 265	28, 32, 20, 34, 41, 38, 26, 23, 28, 31. Mean=(30.6)	Total = 306
	Conventional methods (M_2)	26, 20, 24, 20, 20, 21, 20, 19, 23, 30. Mean=(23.3)	Total = 233	19, 18, 19, 05, 10, 16, 11, 14, 12, 09. Mean=(13.3)	Total = 133

S_1 Total=1017 (Mean=25.42) I_1 Total = 965 (Mean=24.12) M_1 Total=1127 (Mean=28.17)

S_2 Total= 875 (Mean=21.89) I_2 Total = 927 (Mean=23.17) M_2 Total= 765 (Mean=19.12)

Table No. 15. Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Intelligence (I)		Rigidity (R): High rigidity (R_1)		Rigidity (R): Low rigidity (R_2)	
High intelligence (I_1)	Programmed Instruction (M_1)	27, 30, 26, 32, 30, 40, 24, 09, 28, 17.		32, 32, 33, 40, 18, 29, 22, 27, 30, 10.	
		Mean=(27.2)	Total = 272	Mean=(27.3)	Total = 273
	Conventional methods (M_2)	20, 23, 18, 20, 25, 25, 31, 36, 32, 30.		14, 17, 20, 10, 27, 19, 24, 26, 18, 19.	
		Mean=(26.0)	Total = 260	Mean=(19.4)	Total = 194
Low intelligence (I_2)	Programmed Instruction (M_1)	28, 29, 33, 19, 41, 26, 21, 25, 31, 24.		23, 20, 34, 27, 22, 23,25 , 28, 28, 32.	
		Mean=(27.7)	Total = 277	Mean=(27.2)	Total = 272
	Conventional methods (M_2)	27, 19, 22, 32, 18, 25, 11, 16, 14, 30.		19, 22, 19, 30, 25, 16, 20, 20, 21, 09	
		Mean=(21.4)	Total = 214	Mean=(20.1)	Total = 201

R_1 Total=1023 (Mean=25.57) I_1 Total= 999 (Mean=24.97) M_1 Total=1094 (Mean=27.35)

R_2 Total= 940 (Mean=23.50) I_2 Total= 964 (Mean=24.10) M_2 Total= 869 (Mean=21.72)

Table No. 16. Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Introversion (In)

Intelligence (I)		High introversion (In_1)		Low introversion (In_2)	
High intelligence (I_1)	Programmed Instruction (M_1)	32, 26, 21, 30, 28 29, 37, 23, 23, 27		39, 33, 28, 32, 38 33, 39, 24, 34, 12	
		Mean=(23.4)	Total = 234	Mean=(31.3)	Total = 313
	Conventional methods (M_2)	27, 21, 27, 18, 23, 20, 18, 19, 24, 16.		27, 20, 21, 21, 10, 21, 24, 19, 05, 30.	
		Mean=(21.3)	Total = 213	Mean=(19.8)	Total = 198
Low intelligence (I_2)	Programmed Instruction (M_1)	29, 32, 27, 31, 41, 23, 21, 25, 32, 24		23, 37, 32, 34, 17, 29, 23, 19, 25, 33.	
		Mean=(29.0)	Total = 290	Mean=(27.2)	Total = 272
	Conventional methods (M_2)	19, 27, 22, 17, 30, 25, 11, 23, 22, 11.		18, 20, 19, 20, 19, 22, 19, 10, 16, 14.	
		Mean=(20.7)	Total = 207	Mean=(17.7)	Total = 177

In_1 Total= 994 (Mean=24.85) I_1 Total=1008 (Mean=25.20) M_1 Total=1159 (Mean=28.97)

In_2 Total= 960 (Mean=24.0) I_2 Total= 946 (Mean=23.65) M_2 Total= 795 (Mean=19.87)

Table No. 17. Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Previous Achievement (A)		Rigidity (R)			
		High rigidity (R_1)		Low rigidity (R_2)	
High pre-achievement (A_1)	Programmed Instruction (M_1)	32,39,28,28,25,33,29,20, 26,24,23,40,24,25,17.		23,32,21,32,33,32,40,34, 34,18,22,31,33,26,26.	
		Mean=(28.3)	Total = 425	Mean=(29.8)	Total = 447
	Conventional methods (M_2)	37,23,20,25,33,21,31,20, 31,36,32,20,29,30,30.		15,22,23,20,24,26,~~35~~ 25,30, 21,18,22,38,24,36,20.	
		Mean=(26.4)	Total = 397	Mean=(23.6)	Total = 354
Low pre-achievement (A_2)	Programmed Instruction (M_1)	22,32,40,29,28,30,19,20, 25,32,22,31,09,24,25.		20,34,22,29,25,27,12,22, 25,19,26,26,18,12,10.	
		Mean=(25.8)	Total = 389	Mean=(21.8)	Total = 327
	Conventional methods (M_2)	18,19,20,18,14,13,18,21, 20,11,25,25,10,19,15.		19,19,20,18,18,16,12,20, 20,10,10,27,15, 8,12.	
		Mean=(17.7)	Total = 266	Mean=(16.2)	Total = 244

R_1 Total =1476 (Mean=24.60) A_1 Total=1623 (Mean=27.05) M_1 Total=1587 (Mean=26.45) 1587

R_2 Total =1372 (Mean=22.86) A_2 Total=1225 (Mean=20.38) M_2 Total=1261 (Mean=21.01)

1225

Table No. 18. Distribution of retention scores (and their means) in 3 x 3 x 2 factorial design for analysis of variance.

Previous Achievement (A)		I n t r o v e r s i o n (In)			
		High introversion (In_1)		Low introversion (In_2)	
High pre-achievement (A_1)	Programmed Instruction (M_1)	33, 34, 34, 21, 42, 33, 39, 28, 23, 38. Mean=(32.8)	Total = 328	28, 37, 39, 20, 26, 40, 33, 33, 34, 26. Mean=(32.1)	Total = 321
	Conventional methods (M_2)	27, 20, 12, 25, 21, 12, 18, 24, 26, 19. Mean=(20.3)	Total = 203	27, 20, 21, 21, 21, 21, 25, 24, 05, 16. Mean=(20.1)	Total = 201
Low pre-achievement (A_2)	Programmed Instruction (M_1)	20, 29, 27, 41, 25, 12, 36, 23, 24, 24. Mean=(26.4)	Total = 264	22, 29, 22, 33, 20, 27, 25, 19, 31, 17. Mean=(24.4)	Total = 244
	Conventional methods (M_2)	17, 18, 19, 20, 21, 18, 15, 23, 12, 15. Mean=(17.8)	Total = 178	19, 19, 14, 10, 18, 20, 20, 10, 19, 18. Mean=(16.7)	Total = 167

In_1 Total = 973 (Mean=24.32) A_1 Total=1053 (Mean=26.32) M_1 Total=1157 (Mean=28.92)

In_2 Total = 933 (Mean=23.32) A_2 Total= 853 (Mean=21.32) M_2 Total= 749 (Mean=18.72)

Table No. 19. Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Study habits (S)		Introversion (In): High introversion (In_1)		Introversion (In): Low introversion (In_2)	
Good study habits (S_1)	Programmed Instruction (M_1)	32, 33, 34, 32, 38, 27, 25, 31, 28, 37. Mean=(31.5)	Total = 315	28, 31, 41, 20, 30, 33, 22, 39, 24, 26. Mean=(29.4)	Total = 294
	Conventional methods (M_2)	29, 28, 27, 33, 24, 38, 32, 10, 24, 24. Mean=(27.5)	Total = 275	20, 18, 23, 21, 21, 16, 21, 18, 18, 30. Mean=(20.6)	Total = 206
Poor study habits (S_2)	Programmed Instruction (M_1)	23, 37, 29, 34, 23, 28, 30, 26, 23, 17. Mean=(25.4)	Total = 254	27, 18, 19, 19, 14, 10, 19, 22, 19, 05. Mean=(17.2)	Total = 172
	Conventional methods (M_2)	19, 12, 19, 27, 28, 22, 20, 16, 18, 19. Mean=(20.0)	Total = 200	19, 20, 21, 31, 12, 20, 27, 18, 35, 23. Mean=(21.6)	Total = 216

In_1 Total=1054 (Mean=26.35) S_1 Total=1090 (Mean=27.25) M_1 Total=1045 (Mean=26.12)

In_2 Total= 888 (Mean=22.2) S_2 Total= 852 (Mean=21.30) M_2 Total= 897 (Mean=22.42)

Table No. 20. Distribution of retention scores (and their means) in 2 x 2 x 2 factorial design for analysis of variance.

Intelligence (I)

		Previous Achievement (A): High pre-achievement (A_1)		Low pre-achievement (A_2)	
High intelligence (I_1)	Programmed Instruction (M_1)	39, 32, 33, 38, 40, 38, 33, 32, 39, 23. Mean=(33.2)	Total = 352	21, 30, 33, 20, 31, 20, 19, 20, 17, 24. Mean=(23.4)	Total = 234
	Conventional methods (M_2)	27, 23, 17, 21, 18, 29, 31, 36, 25, 26. Mean=(25.3)	Total = 253	19, 13, 17, 20, 10, 25, 27, 25, 10, 19. Mean=(19.0)	Total = 190
Low intelligence (I_2)	Programmed Instruction (M_1)	28, 28, 37, 32, 28, 30, 28, 34, 33, 32. Mean=(31.3)	Total = 313	32, 40, 29, 29, 22, 19, 21, 41, 22, 31. Mean=(23.6)	Total = 286
	Conventional methods (M_2)	27, 23, 21, 20, 33, 30, 21, 27, 24, 30. Mean=(24.6)	Total = 246	19, 18, 19, 18, 10, 20, 30, 23, 12, 11. Mean=(18.0)	Total = 180

A_1 Total=1164 (Mean=29.1) I_1 Total=1029 (Mean=25.72) M_1 Total=1185 (Mean=29.62)

A_2 Total= 890 (Mean=22.25) I_2 Total=1025 (Mean=25.62) M_2 Total= 869 (Mean=21.72)